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Disease Control Priorities in Developing Countries: An Overview

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International health policy is at a time of transition. A pre-transition environment dominated by high fertility, high mortality, infectious disease, and malnutrition is giving way to a low-mortality, low-fertility environment. For the past two decades much of the international public health community has focused attention on the communicable childhood diseases (CCDs). Although there are exceptions to this generalization—continued concern about the tropical diseases, for example—much of the debate and analysis has concentrated on whether CCD problems would be best addressed by broad-reaching strategies or by selective ones. Significant technical and programmatic progress has been made in this period, and the focus of concern on CCD has clearly been appropriate: the problems are great; the technological and epidemiological tools have become powerful; and the payoff for adapting and applying what is known is very high. The success of CCD control efforts combined with large and sustained fertility reductions in many developing countries has led, however, to the "health transition," that is, the change from a pretransition environment dominated by high fertility, high mortality, infectious disease, and malnutrition to a low-mortality, low-fertility environment with a disease profile that increasingly emphasizes noncommunicable conditions of adults and the elderly.[1] Figure 1-1 illustrates the progress of the health transition through demographic to epidemiologic change.

This collection reports the findings of the Health Sector Priorities Review, a review conducted by the World Bank of the implications for disease control priorities of the health transition. The core of this collection consists of analyses undertaken for the Health Sector Priorities Review that assess the significance to public health of individual diseases (or related clusters of diseases) and of what is now known about the cost and effectiveness of relevant interventions for their control.[2] To the extent possible, the cost-effectiveness of intervention has been summarized by estimates of marginal cost per disability-adjusted life-year (DALY) gained; although this measure is imperfect, and often varies with the scale of the control effort and across environments, its estimation, for each of a large number of interventions, does indicate priorities for
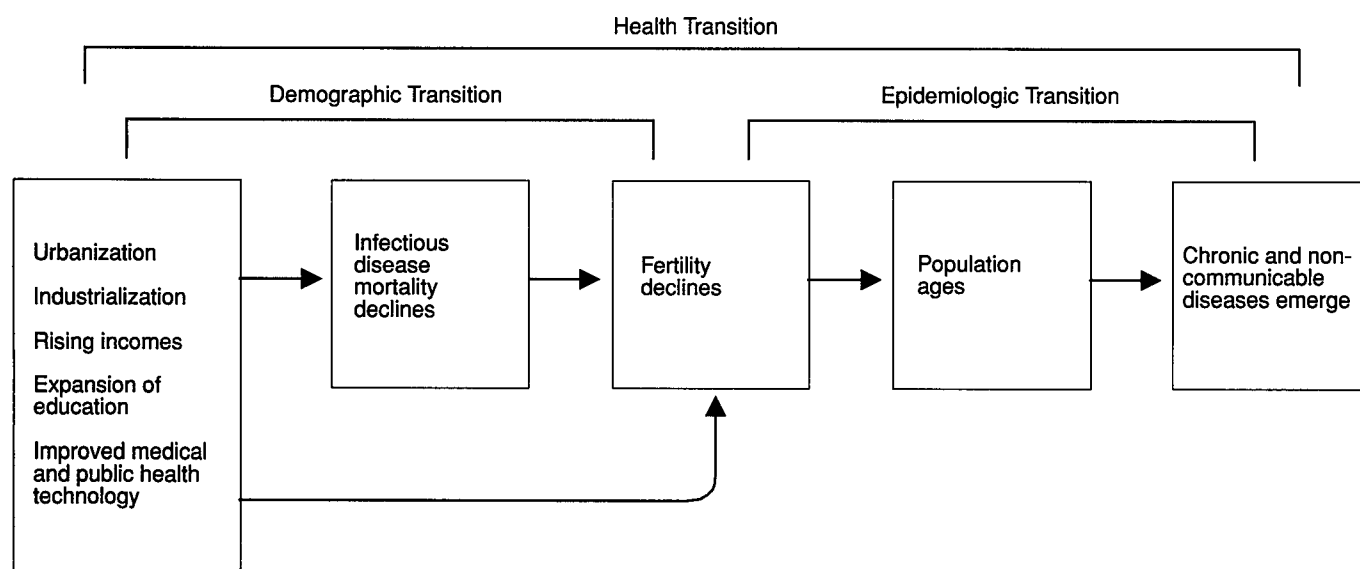
the allocation of resources to disease control. By addressing a broad range of conditions, the World Bank Health Sector Priorities Review was able both to estimate the cost-effectiveness of CCD interventions and to place them into the context of interventions for noncommunicable diseases and for communicable diseases of adults.[3]

This chapter has three purposes: to set the context for the collection as a whole by describing the Health Sector Priorities Review and outlining the methods of cost-effectiveness analysis used; to summarize the findings of the condition-specific analyses, which are reported in parts 2, 3, and 4 of this collection; and to draw a few broad conclusions. In chapter 29, Mosley, Bobadilla, and Jamison describe the health transition more fully and provide an amplified set of implications for policy.

Before proceeding with the substance of the chapter, I will put forth four caveats. First, any general discussion of conditions and priorities for so vast and diverse a set of countries as those that make up the developing world naturally runs the risks of overstating generalities and understating differences. The authors represented in this collection assume the reader to be already familiar with this diversity, and, therefore, we avoid continually repeating caveats about the limits to generalization. Nevertheless, our concern is with generalization—with addressing trends and findings that are important for a sufficiently large number of countries that they assume significance for the developing world as a whole. That said, the conclusions of this chapter, and of the collection as a whole, can best be viewed as a useful starting point for country-specific analyses and certainly not as a substitute for them.

A second caveat concerns limits to the coverage of the World Bank Health Sector Priorities Review. One shortcoming is the lack of attention to most mental and neurological illness; analyses structured like those in this collection for a broader range of neuropsychiatric conditions may be initiated soon, but results are currently unavailable.[4] Many other conditions—some minor, some more important—were omitted in order to keep the scope of the review manageable. Likewise, interventions associated with the very diverse range of tradi-

Figure 1-1. Relationships between Demographic, Epidemiologic, and Health Transitions

Health Transition

Demographic Transition

Epidemiologic Transition

| Urbanization Industrialization Rising incomes Expansion of education Improved medical and public health technology | → | Infectious disease mortality declines | → | Fertility declines | → | Population ages | → | Chronic and non-communicable diseases emerge |

Source: Chapter 28.

tional medical practices were not included. These gaps in coverage genuinely limit the scope of the review. But I feel they do not significantly alter conclusions concerning the very broad range of conditions and interventions that were included.

A third caveat concerns the perspective of this document, which is that of governments or of development assistance agencies working with governments. Other perspectives—those of clinicians or of patients or of nongovernmental organizations, for example—are also important, and this review's findings concerning intervention cost-effectiveness have some relevance from those perspectives. But the review's main purpose is to identify those interventions that, on the basis of their cost-effectiveness, governmental policy should seek to encourage or discourage.

Fourth, we assume throughout this collection that the analysis of health policy can usefully be divided into three tasks: to choose attractive interventions; to design delivery systems for such interventions; and to choose appropriate governmental instruments to encourage these interventions. Because of the changing pattern of disease, delineated in chapters 3 and 29, this collection readdresses the first task of health planning, that of choosing interventions. For this reason I take the time here to consider the three tasks together. The first task, choosing interventions, assesses the cost-effectiveness of potential disease control technologies by combining technical analysis (epidemiological and clinical) with economic considerations; it will also, occasionally, extend to the task of assessing the benefits of intervention in relation to cost broadly defined.[5] The second task, designing delivery systems, has dominated thinking about health policy. Economically sensible delivery systems, however, must follow choice of what interventions are

to be implemented. In either the public or private sector the three key design elements for delivery systems—planning development of human and physical infrastructure, planning the logistical system for drugs and supplies, and planning appropriate information and incentive structures and financial instruments—all depend in important ways on the intervention mix. At the same time, the cost-effectiveness of interventions will vary with the capacity of local infrastructure to deliver them (Over 1988), as is well illustrated in chapter 14, "Dengue," by Halstead and Shepard. Ideally, then, the first two tasks of health policy analysis should be addressed iteratively rather than sequentially. The third task of policy, choice of the appropriate mix of governmental instruments, deals with what governments can do through provision of information, taxation, regulation, direct investment, and research.[6] The brief discussion of these instruments in this chapter points to their importance; it does not assess them in any depth.

If the familiar pattern of problems in developing countries—communicable childhood disease, undernutrition, and excess fertility—could be expected to continue their dominance of the epidemiological profile, then there would be little need for the broad reassessment of objectives attempted in this collection. Analyses aimed at improving the infrastructure, logistics, and financial aspects of the delivery systems so they are able to deal with the pretransition conditions could simply proceed. But massive epidemiological change is already deeply penetrating the developing world, and response to this change has typically been to import the high-cost approaches of the industrialized nations to the (very limited) extent that resources permit—hence the timeliness of broad assessment of the cost-effectiveness of intervention options. Reassessment of the design of delivery systems and the appropriate role for govern-

ment also claims priority; but that reassessment must follow identification of the interventions to be delivered (or encouraged) and those to be discouraged.

The World Bank's 1980 policy paper on the health sector (World Bank 1980) focused on communicable diseases of childhood, but shortly after that paper was published another widely cited paper prepared at the World Bank (Evans, Hall, and Warford 1981) was drawing attention to the emergence of behavioral disorders and noncommunicable disease as significant problems in many developing countries. Although Evans, Hall, and Warford were explicitly pessimistic about prospects for cost-effective intervention to address these emerging problems, World Bank staff members were encouraged to begin addressing the issue in their work with individual governments, and analyses for China (Jamison and others 1984; Bumgarner and others 1990) and Brazil (Briscoe and others 1989) attempted to develop relevant policy responses in epidemiological environments characterized both by lingering problems of childhood disease and malnutrition and by rapid emergence of noncommunicable disease (NCD).[7] During the progress of these country studies it became clear that very little analysis indeed had gone into the task of selecting from and adapting the broad range of NCD interventions available in the industrialized countries to generate options relevant to the extremely cost-constrained environments of developing countries.

This lack of analysis of appropriate approaches for developing countries to take in dealing with NCDs provided the impetus, then, for the World Bank Health Sector Priorities Review. At the same time it seemed appropriate to reassess the cost-effectiveness of interventions addressing communicable conditions, malnutrition, and excess fertility; such a reassessment would both provide the context for judging the relative cost-effectiveness of interventions for NCDs and allow judgments to be made on intervention priority for child survival.

The World Bank Health Sector Priorities Review

The most important part of the review is a series of analyses on diseases and conditions of great importance in part or all of the developing world.[8] The first part of table 1-1 lists the included topics and indicates which chapter of the collection covers them; the second part lists potentially important conditions that were not included but that, ideally, should be addressed in further work. The authors of each chapter were asked to undertake three tasks: to assess the current and probable future public health significance of the conditions in developing countries; to judge the cost and effectiveness of alternative approaches to preventing the condition in different contexts; and to judge the cost and effectiveness of alternative approaches to case management for the conditions in various contexts. Ideally each chapter would have been written by an economist, an epidemiologist, and a clinician or biomedical scientist. Although each of these categories is well represented among the chapter authors, relatively few of the individual chapters ended up with all three.

Table 1-2 provides definitions of terms that are frequently used in this chapter and throughout the collection. After reviewing drafts of all the chapters, I concluded that dividing interventions between those that are public health oriented and those that are clinically oriented was more useful than distinguishing between preventive and case management interventions, a distinction that the chapter authors had originally been asked to make. In table 1-2 I define how we use these terms, and later in this chapter I divide the summaries of the findings of the condition-specific chapters into two sections, one on public health intervention and the other on clinical intervention.

In table 1-2 I also define the objectives of intervention, which, as we categorize them, include primary prevention, secondary prevention, cure, rehabilitation, and palliation. Although there is some tendency for public health interventions to have primary prevention as their main objective, this is far from universally true; by the same token, some clinical interventions also seek primary prevention. Hence the importance of clarity about objectives in discussing individual interventions. Table 1-2 also defines the instruments of government policy that can be used to encourage or discourage use of specific interventions.

The cost-effectiveness of any given intervention varies according to circumstances, and the main sources of such variation are discussed in the next section. A particularly important source of variation, however, results from the general mortality level of the environment, and each set of chapter authors was asked to consider two environments (if relevant to their conditions). One of these was a high-mortality, high-fertility environment with low gross national product (GNP) per capita and extremely limited resources available for the health sector; Nigeria might be an example. The other was an environment with relatively low fertility and mortality, a middle-income GNP, and more substantial resources for the health sector; Thailand would be typical here. Many of the authors of the disease-specific analyses used both these paradigms, whereas others used only one or found neither appropriate. What is important to note here, though, is that conclusions concerning intervention attractiveness can vary quite substantially depending on a country's progress through the health transition and that this point was very much a starting point for the analyses in the World Bank review.

Assessing the Cost-effectiveness of Intervention

This section contains a discussion of general issues associated with choosing interventions, that is, with criteria for cost-effective choice. The nature of the instruments open to government to promote cost-effective intervention is discussed in chapter 29. The purpose in both chapters is not to provide an account of methodological issues associated with economic assessment of intervention options; rather we wish simply to describe the basic concepts being applied and refer the reader to the relevant literature (for example, Drummond, Stoddart, and Torrance 1987).

Table 1-1. Selected Clusters of Diseases and Conditions

Status	Unfinished agenda	Emerging problems
Included	*Infections principally affecting children* Acute respiratory infections (chap. 4) Diarrheal diseases (chap. 5) Poliomyelitis (chap. 6) Helminthic infections (chap. 7) Measles (chap. 8) Tetanus (chap. 9)	Human immunodeficiency virus infection and sexually transmitted diseases (chap. 20) Cancers (chap. 21) Diabetes (chap. 22) Cardiovascular disease (chap. 23) Chronic obstructive pulmonary disease (chap. 24) Injury (chap. 25) Cataract (chap. 26) Oral health (chap. 27) Schizophrenia and manic-depressive illness (chap. 28)
	Other infections Rheumatic heart disease (chap. 10) Tuberculosis (chap. 11) Leprosy (chap. 12) Malaria (chap. 13) Dengue and yellow fever (chap. 14) Hepatitis B (chap. 15) *Reproductive health and malnutrition* Excess fertility (chap. 16) Maternal and perinatal health (chap. 17) Protein-energy malnutrition (chap. 18) Micronutrient deficiency disorders (chap. 19),	
Omitted	Lymphatic filariasis African trypanosomiasis Chagas' disease Leishmaniasis Skin diseases	Epilepsy Affective disorders Alcohol and other drug abuse Arthritis Influenza Appendicitis Hernia

Source: Author.

The methods of assessing the cost and effectiveness of intervention vary from chapter to chapter, complicating the task of cross-chapter comparisons of the cost-effectiveness of intervention. Because of wide variation in the nature of the conditions and the adequacy of the literature, the chapters vary in the extent to which they provide quantitative estimates of cost-effectiveness; hence the results are sometimes difficult to compare. Nevertheless, the authors proceeded with similar objectives and methods, and, if one accepts the results as reasonable first approximations, the collection does generate the raw materials for comparative assessment of the cost-effectiveness of intervention. Often these first approximations rely on epidemiological or clinical judgments combined with the results of published studies, or, in those cases where published data were unavailable, judgments were made on the basis of discussion with experienced observers. Some reviewers of this effort have been uncomfortable with the explicit use of judgmental assessments; we have consistently encouraged them to let us know of any cases where current clinical or public health decisions are being made on the basis of better information on efficacy or cost than we use.

A critical choice in applications of economic analysis to resource allocation is that of whether to value outcomes be-cause of their economic benefits or because of some more proximal effectiveness measure. Ideally, economic benefits would be the criterion; the results of the analysis—phrased in dollars of output value given the dollar value of inputs—provide standards for assessment of interventions across sectors: immunization as against irrigation as against smaller class sizes, say. When there are good markets for products, benefits can be assessed in monetary terms by using market prices (that is, willingness of consumers to pay) to value benefits. Even when willingness-to-pay valuation cannot be assessed directly because of lack of market prices, as is typically true in the health sector, questions in surveys are increasingly being used to elicit information about hypothetical willingness-to-pay. Briscoe and de Ferranti (1988) indicate the potential for this approach in valuation of water projects, but applicability in the health sector remains to be assessed. Nonetheless, pervasive problems of consumer ignorance of effectiveness of intervention (previously discussed) and a widespread tendency for individuals systematically to underestimate risks (Weinstein 1989) suggest that willingness-to-pay assessments will probably have limited application to health. An alternative approach—sometimes called the human capital approach—is to view health investments as instrumental to improving economic productivity;

Table 1-2. Definition of Terms

1. *Interventions.* The term "intervention" is used in this chapter to denote actions taken by or for individuals to reduce the risk, duration, or severity of an adverse health condition. Interventions are the *proximal* cause of deliberate changes in risks, duration, or severity; instruments of policy (see below) encourage, discourage, or undertake interventions. Stopping smoking, for example, is an intervention that an individual can take to reduce risk from a range of diseases; taxing tobacco products is a potential instrument of government policy to encourage this intervention. I divide interventions into those that are "public health" and those that are "clinical."

    1.1 *Public health interventions.* These are interventions sought of or directed toward entire populations or population subgroups; this chapter divides public health interventions into five broad categories—change of personal behavior, control of environmental hazards, immunization, mass chemoprophylaxis, and screening and referral. (Table 1-5 provides a broad range of examples of each of these strategies for population-based intervention.)

    1.2 *Clinical interventions.* These are interventions provided at facilities, usually to individuals. This chapter divides clinical interventions into those that can be provided at the clinic (community, private, work-based, or school-based), at a district hospital, or at a referral hospital.

2. *Objectives of Intervention.* The objectives of intervention are structured, in this chapter, into five categories:[a]

    2.1 *Primary prevention* aims to reduce the risk of a condition occurring by lowering the level of risk factors or instituting policies to forestall their emergence. (This latter is sometimes referred to as "primordial prevention.")

    2.2 *Secondary prevention* aims to reduce the duration or severity of a condition or physiological risk factor in order to forestall its leading to more adverse consequences.

    2.3 *Cure* of a condition aims to remove its cause and restore function to the status quo ante.

    2.4 *Rehabilitation* aims to restore (or partially restore) physical, psychological, or social function resulting from a previous or chronic condition.

    2.5 *Palliation* aims to reduce pain and suffering from a condition for which no means of cure or rehabilitation is currently available. (This may range from the use of aspirin for headaches to use of opiates to control terminal cancer pain.)

3. *Instruments of Policy.* These are the activities that can (potentially) be undertaken by governments or other entities that wish to encourage or discourage interventions, or, importantly, to expand the menu of potential intervention. I distinguish five major instruments or policy:

    3.1 Use of *information, education, and communication* (IEC) seeks to improve the knowledge of individuals (and service providers) about the consequences of their choices.

    3.2 Use of *taxes and subsidies* on commodities, services, and pollutants seeks to effect appropriate behavioral responses.

    3.3 Use of *regulation and legislation* seeks to limit availability of certain commodities, to curtail certain practices, and to define the rules governing finance and provision of health services.

    3.4 Use of *direct expenditures* seeks to provide (or finance provision of) selected interventions (e.g., immunizations) or to provide infrastructure (e.g., medical schools) that facilitates provision of a range of interventions.

    3.5 Undertaking *research and development* (or encouraging them through subsidies) is an instrument central to the goal of expanding the range of interventions available and reducing their cost.

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a. The International Epidemiology Association's *Dictionary of Epidemiology* (Last 1988) provides a helpful discussion of different types of prevention but, interestingly, has no entries for "cure" or "rehabilitation." Their term "tertiary prevention," which is not used here, seems to encompass both "rehabilitation" and "palliation," as we define those terms.

Source: Author.

estimates of the effect of a health intervention on productivity thus provide a lower bound to total benefits. One example comes from assessing the effect on the productivity of rubber plantation workers of correcting iron deficiencies (Basta, Soekirman, and Scrimshaw 1979; Levin and others, chapter 19, this collection); other examples come from assessment of the effect on productivity of malaria control efforts (Najera and others, chapter 13, this collection). It is worth noting that willingness-to-pay and human capital approaches tend to imply different values to be attached to the life of different individuals of the same age in the same country. Phelps and Mushlin (1991) discuss relations between cost-effectiveness and cost-benefit analyses of health projects; they conclude that willingness to set a cutoff level of acceptable cost-effectiveness results in equivalence between cost-effectiveness and cost-benefit approaches.

More typically, however, outcomes will be assessed in deaths or disability averted, and the task is to come up with some

measure for making such an assessment that allows comparisons across the health sector, even if intersectoral comparisons (cost-benefit analyses) remain infeasible.[9] There is now a valuable literature on how effectiveness measures to aggregate the disability-, morbidity-, and premature mortality-averting effects of interventions across the health sector might be constructed and applied (Barnum 1987; Zeckhauser and Shepard 1976; Over 1988; and Feachem, Graham, and Timaeus 1989). Such measures, in addition to providing the effectiveness measures for cost-effectiveness analyses, can be used with epidemiological information to assess the burden of disease in a population, as has recently been done for the major regions of the world (World Bank, 1993). Nonetheless, inherent difficulties remain, and these are usefully discussed in Murray (1990). Table 1-3 sets forth the characteristics of the main approaches to effectiveness measurement in the literature; from a practical perspective, the use of ratings based on expert judgment is probably the best that can now be done if the

purpose of the analysis is to compare interventions across the sector, although, as Preston (1991) has noted, these measures must be used with care. This has been the approach adopted in the World Bank Health Sector Priorities Review.

I conclude that a workable measure for effectiveness for most of the analysis will be disability-adjusted life-years gained (or DALYs). The DALY gain associated with averting a death is, simply, the number of years between the age at which the death would have occurred and the individual's expected age at death, given survival to the given age, with years gained in future years discounted back to the present at a discount rate of 3 percent per annum in all chapters in this collection. Unhealthy life-years are given lower weights than healthy ones, depending on degree of disability (by the rating procedure described in the preceding paragraph) so that the effectiveness of interventions to address morbidity or disability can be measured in terms that permit comparison with interventions that avert mortality. The DALY measure used in this

collection is a particular form of the more general concept of "quality-adjusted life-year" (QALY) introduced by Zeckhauser and Shepard (1976).

Garber and Phelps (1992) provide the basic theoretical underpinnings for cost-effectiveness analyses in health that adjust life-years for quality. (See Johannesson [1992] for a general discussion of discounting healthy life-years, and see Cropper, Aydede, and Portney [1992] for empirical assessments of time preference for saving lives.) Authors of individual chapters assess the losses due to disability or morbidity in ways judged suitable to the conditions with which they are dealing. Thus, reduction in morbidity and disability can be explicitly considered in the analysis, and most chapters do so, if the conditions they deal with have significant consequences other than death. The approach used here explicitly values years of healthy life at all ages equally; this assumption can be readily relaxed, however, to give greater weight to those age groups likely, say, to have more dependents (Musgrove 1991).

Table 1-3. Alternative Approaches to Measuring Effectiveness of Intervention

Approach to measurement	Cost	Possible bias	Applicability[a]	Example
Mortality				
Deaths averted	Very low	Highly biased conditions involving disability	Medium	Assessment of priorities in child survival (Walsh and Warren 1979)
Years of potential life lost	Very low	Highly biased against conditions involving disability	Medium	Regularly used by Centers for Disease Control to assess burden of disease in the United States, (MMWR 1992)
Quality-of-life adjusted life-years[b]				
Expert ratings assessment	Low	Unrepresentative experts	High	Ghana Health Assessment Project Team (1981); this collection
Survey-based	Medium	n.a.	Low (in practice)	Rosser scale (Rosser and Kind 1978); European quality-of-life assessments (EuroQol Group 1990)
Risk tradeoffs	High	Questionable relevance of artificial gambles	Low (in practice)	Various quality-of-life assessments (Tan-Torres 1990)
Quantity-of-life high tradeoffs: Individual length vs quality of life	Medium/high	Probably low for patient-level decisionmaking	Medium	Various quality-of-life assessments (Tan-Torres 1990)
Quantity-of-life tradeoff: Across individuals	Medium	Probably low for social decisionmaking	Medium/high	Vaccine development study (Institute of Medicine 1986; Nord 1991)
Calibration of preexisting condition-specific studies	Medium	Probably low	Low	Cairns and Johnston 1991

n.a. Not applicable.

Note: This table does not review approaches to measuring the economic benefits of changes in health status. Such measures—based, for example, on willingness to pay for reductions in the probability of adverse outcomes or on assessment of health-related determinants of labor productivity (human capital)— allow conclusions to be drawn about the attractiveness of particular health interventions relative to their cost, not simply by comparison with other interventions (for examples, see chapter 19). No usable set of benefit measures is available across conditions.

a. Availability for application in health-sector-wide cost-effectiveness studies.

b. Each of the methods for quality of life measurement—ratings, risk tradeoffs, quantity-of-life tradeoffs, calibrations—can be undertaken by different groups, possibly with different results. The groups can be of "experts," respondents to a survey, or, in a clinical setting, potential patients. For the ratings method, this table comments on both expert and survey approaches: a similar breakdown could be provided for each method. See Fallowfield (1990) for a general discussion of these matters.

Source: See references in final column of table.

Costs are generally assessed at market prices. In some cases, however, for some inputs into health care, costs may be lower in developing countries (for example, for semiskilled labor). These costs are typically for inputs that cannot be traded internationally, and their existence undermines attempts to estimate costs that are not simply country-specific. Squire (1989) provides a general discussion of approaches to dealing with nontradables in project analysis; his results, though, are more relevant to country-specific assessments than to cross-national comparisons.

The working conclusion of this chapter is that for drugs, for most equipment, and for high-level manpower, considerations of cost variability between high- and low-income countries are essentially irrelevant. For facilities and lower-level manpower they are likely to change some numbers, but in most cases costs can more reasonably be expressed in constant dollars than, say, as fractions of local per capita income—a method that assumes essentially no health sector inputs to be internationally tradable. The chapters "Cancer," by Barnum and Greenberg (chapter 21, this collection), and "Tuberculosis," by Murray, Styblo, and Rouillon (chapter 11, this collection), attempt to divide costs into those for traded goods and those for nontradables. Their assessments do suggest that local costs will often be important and that those who attempt to assess the cost-effectiveness of intervention in a country-specific context should pay close attention to this issue unless there is a com-

pletely free market for foreign exchange and the costs of nontradables are similar to those of the comparator country.

Another important issue in cost analysis concerns assessment of the amount and value of time required of patients or caretakers; the importance of mothers' time, in particular, for compliance with child survival interventions has been stressed by Leslie (1989). These time costs are potentially difficult to value (Briscoe and de Ferranti 1988) and have been neglected in this collection. It is hoped that subsequent work will redress this omission. A related issue concerns treatment of costs that will ensue from intervention success; Levin and others (chapter 19, this collection) point out that substantial food costs can result from micronutrient supplementation or parasite control. The existence of such costs suggests the importance, in these cases, of broadening the definition of the intervention.
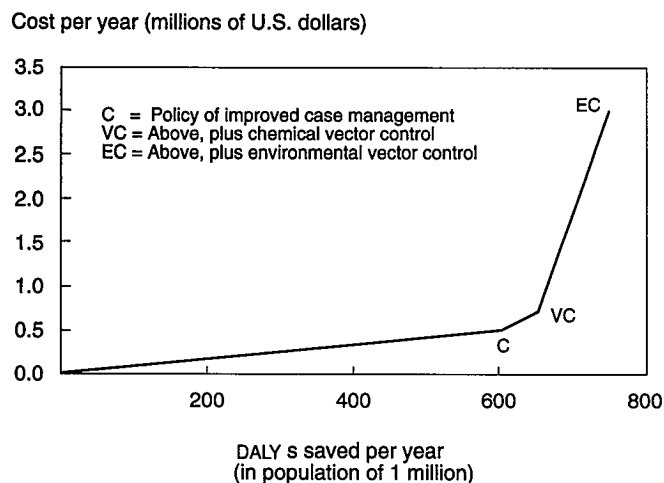
A final issue concerning cost analysis is that of joint costs, that is, the situation where several interventions are essentially made available with a (partially) common set of inputs. The chapters in this collection handle this in part by defining interventions in terms of natural packages; the chapter "Poliomyelitis," by Jamison and others (chapter 6, this collection), considers the preventive intervention for polio to be diphtheria-pertussis-tetanus vaccine plus polio immunization, and assesses the cost-effectiveness of that package, because polio immunization would (almost always) be given with the vaccine. In many cases, however, such packaging would get too

Table 1-4. Factors Influencing Variation in Cost-Effectiveness

Influencing factor	Examples
Epidemiological environment	
Prevalence of condition	Screening and referral programs for leprosy; for cervical and breast cancer
Incidence of condition	BCG immunization for tuberculosis; preventive measures for many injuries
Case-fatality rate	Measles immunization; oral rehydration therapy for diarrhea
Transmission dynamics of infectious conditions	Treatment of sexually transmitted diseases in core vs noncore groups; vector control for malaria, dengue
Existence of competing risks of synergisms	Measles vaccination: amplification of cost-effectiveness by strengthening individuals in a general way. Among the very young or elderly, competing risks reduce the cost-effectiveness of some targeted interventions.
Individual characteristics	
Age	Cancer treatment: more cost-effective for younger patients
Tendency to compliance	Tuberculosis chemotherapy; antihypertensive medication
Tendency to self-refer	Sexually transmitted diseases control
Levels of risk factors	Hypertension and hyperlipidemia
Individual variation in values	Attitude toward disability relative to risk of death; can lead to individual differences in intervention effectiveness
System characteristics	
Local costs of non-traded inputs to health care system	Real costs of care-intensive interventions (such as hospitalization to ensure compliance with tuberculosis chemotherapy) are low where wages are low, because most health care personnel are relatively immobile
Generalized systemic competence	Case management of dengue hemorrhagic fever: high cost and low effectiveness in unsophisticated systems. Cost-effectiveness, at the margin, of some interventions in a system with high level of professionalism and capacity may be much less than in less well developed systems
Discount rate	Hepatitis B immunization: where discount rates are high, interventions with payoffs well into the future become relatively less attractive, and age of the patient becomes a less significant determinant of cost-effectiveness

Source: Author.

Figure 1-2. Increasing Costs per Disability-Adjusted Life-Year Associated with More Complete Control of Dengue

Cost per year (millions of U.S. dollars)

C = Policy of improved case management
VC = Above, plus chemical vector control
EC = Above, plus environmental vector control

DALY s saved per year
(in population of 1 million)

Source: Chapter 14.

bulky and the chapter authors have simply been asked to do the best they could while noting where joint costs would need to be considered in country-specific applications.

In this collection, then, for comparison across interventions we use the common denominator of dollar cost per DALY gained, with the understanding that intervention costs and cost-effectiveness will likely vary across locales (even after controlling for intervention quality) because of differences in individuals, in epidemiological conditions, in delivery system characteristics, and in the degree of penetration of the intervention into the population. Table 1-4 lists many important factors that lead to variation in cost-effectiveness, and, to the extent that interventions are first applied where their cost-effectiveness is highest, these factors collectively will lead to rising costs per DALY with increased application of an intervention.[10] Figure 1-2 illustrates this for control of dengue; up to a point, improved case management is most cost-effective, but beyond that point, if a higher level of control for dengue is to be sought, chemical and then environmental strategies of vector control must be introduced.

This phenomenon of rising costs per DALY comes up implicitly in many of the chapters; the cause of the phenomenon is, frequently, the lack of intervention specificity and, also frequently, costly targeting and compliance problems. *Intervention specificity* refers to what fraction of intervention recipients would benefit assuming that the intervention is applied exactly to the individuals to whom it should be applied (the factors "Prevalence of condition," "Incidence of condition," and "Levels of risk factors" in table 1-4). Take BCG (bacille Calmette-Guérin) vaccination as an example; it should be applied to all newborns, but it is a benefit, ex post, only to that tiny fraction of children who would have died in childhood from miliary tuberculosis (TB) without it. Tuberculosis chemo-

therapy for sputum positives, by contrast, although costly, will virtually never be applied when unneeded; it is highly specific. Targeting BCG or other interventions to populations at highest risk, at least until full coverage can be afforded, will maximize cost-effectiveness while simultaneously advancing equity objectives (Mosley and Jolly 1987). As an illustration, figure 1-3 (from Murray, Styblo, and Rouillon, chapter 11, this collection) shows how BCG cost-effectiveness improves with rising risk of infection (and, hence, rising intervention specificity), whereas chemotherapy remains of essentially constant attractiveness.

In addition, targeting costs and compliance costs can dilute cost-effectiveness. Treatment can be very cost-effective for self-referred compliant patients ("Tendency to compliance" and "Tendency to self-refer" in table 1-4); as compliance becomes more problematic, or targeting more costly, cost-effectiveness decreases. For example, oral rehydration therapy (ORT) in the hospital or clinic setting is highly cost-effective; it will only be used for severe cases of diarrhea, and it is likely to be applied effectively by qualified medical personnel. When ORT is taken to the community, however, cost-effectiveness declines substantially, both because of a decrease in intervention specificity (mild cases will be treated unnecessarily) and because home treatment will be applied less effectively than hospital treatment in severe cases. Similarly, targeting costs can be decreased if an immunization program to prevent neonatal tetanus shifts from trying to reach pregnant women to immunizing all childbearing women, although there will be a loss of specificity (at least with respect to preventing neonatal tetanus but not, presumably, with respect to adult tetanus).

Figure 1-3. Cost-Effectiveness of BCG Immunization and Tuberculosis Case Treatment as Function of Annual Risk of Infection

Cost per death averted (U.S. dollars)


Annual risk of infection (percentage)
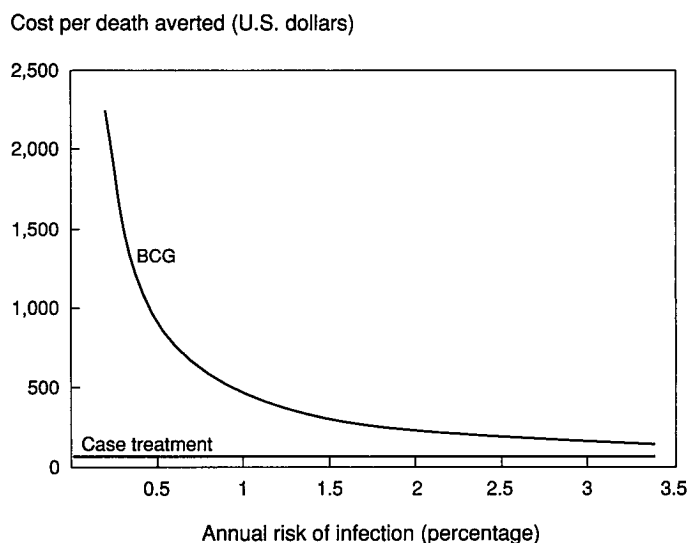
Source: Chapter 11.

When an intervention requires large fixed costs, total program costs need to be weighed against total effects; simple assessment of marginal cost and effectiveness fails to suffice. The fixed costs involved in, to take several examples, investing in major facilities, mounting a media-based health education program, or devising regulations and procedures can be substantial. Fixed costs need not be financial; managerial or political attention to a problem may have an important fixed cost element. When fixed cost may be important, understanding the total burden of disease is necessary for estimating potential total intervention effects (Mooney and Creese, appendix C, this collection).

These points are relatively obvious, but there is often an optimistic bias toward assessing cost-effectiveness under assumptions of favorable targeting and compliance costs and of favorable intervention specificity. One might expect, as previously noted, rising marginal costs and decreasing marginal effectiveness as interventions are extended through populations; these combine to dilute cost-effectiveness. Thus favorable case cost-effectiveness estimates can be real, but their margin of applicability may be limited. In principle, it is desirable to acquire some sense of the responsiveness of intervention cost-effectiveness to a range of parameters, particularly the extent of application of the intervention. In practice, sensitivity analysis is sometimes possible but often difficult—and comparisons are then made for "representative" estimates of marginal cost-effectiveness to provide general guidance to decisionmakers. When there are great differences in the marginal cost-effectiveness of different interventions—as this chapter concludes there to be—this "general guidance" can suggest important redirections of policy.[11] Figure 1-4 illustrates how differences in marginal costs per DALY across interventions can lead to inefficiency. In that example, intervention B is assumed to have a constant cost per DALY of $60 for the range of expenditure levels considered (up to $4,000); intervention A starts with a lower cost per DALY ($20) but one that is rising to $100 per DALY at an expenditure of $4,000. The point here is that when, at prevailing levels of expenditure on each intervention, cost per DALY is lower for one of them (as it would be for A at an expenditure of $1,000 on each of them), reallocation of money will increase output without increasing cost. Hence, the previous allocation would have been inefficient.

Finally, it is worth reiterating that the assessments to be summarized in this chapter provide only an ordering of interventions based on estimates of current marginal cost-effectiveness; epidemiological information is required to assess how much of each intervention needs to be acquired in light of rising costs per DALY gained (Prost and Jancloes, appendix D, this collection). For example, one of the most cost-effective interventions (for adults) is screening hospital blood supplies for human immunodeficiency virus (HIV) seropositivity; as cost-effective as this may be, relatively few deaths can be averted by it. Chemotherapy for patients with tuberculosis, conversely, although somewhat less cost-effective, could be expected to save hundreds of times more lives. Resource allo-

Figure 1-4. Reaching Optimum Intervention Levels

Cost per DHLY (U.S. Dollars)

Annual expenditure on each intervention ($)
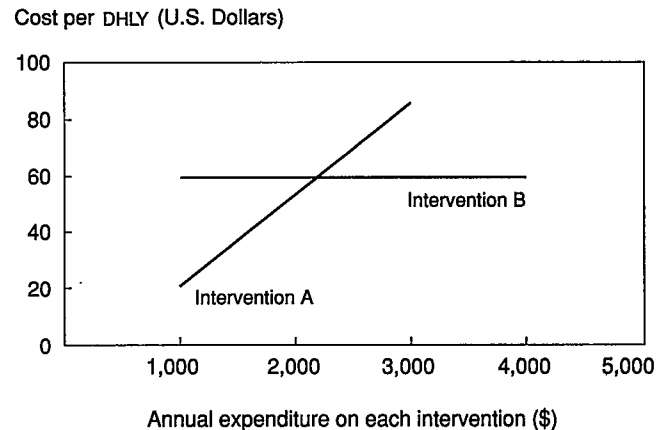
Source: Author.

cation, then, for interventions, depends on both economic and epidemiological information because of the strong effect of epidemiology on the rate of increase in marginal costs. (Resource allocation to research, by contrast, should be driven much more by the epidemiological significance of diseases and researchers instincts about where advances might be realized.)

The Findings: Public Health Interventions

In this section I summarize the findings of the twenty-five condition-specific chapters of this collection. In the first section I noted our conclusion that dividing interventions into two broad categories—public health and clinical—was most conducive to discussing policy tradeoffs, and these summarizing remarks are so divided. (Table 1-2 defined what is included in each of these categories.) This section deals with public health interventions, and the following section deals with clinical ones.

Five Strategies of Public Health Intervention

Public health interventions are organized into five separate strategies in this collection—those designed to change personal behavior, to control environmental hazards, to immunize, to provide mass chemoprophylaxis, and to establish mechanisms for screening and referral. Appendix table 1A-1 lists various components of each of these strategies and provides examples of the condition(s) they might effectively address; this summary of the review's findings on public health intervention will, then, explicitly indicate which of these strategies is being assessed. I feel that in reviewing health policies, or intervention alternatives, it will often be useful to do so within each of these five broad strategies because of commonalities of logistics, policy instruments, and approaches within each. (This is true despite the frequently great diversity of conditions to be addressed within any one intervention strategy.)

Before turning to the condition-by-condition summary of findings, I should touch on the issue of joint costs (and multiple outcomes) of interventions in light of conclusions from the individual chapters. The analysis upon which this collection is based is structured by diseases (or adverse health conditions more generally), and the issues addressed in the individual chapters thus concern the nature, cost, and effectiveness of the interventions available for dealing with each condition. In many cases, of course, any given intervention will address multiple conditions and, indeed, may well have important effects outside the health sector altogether. Perhaps the clearest examples are control of smoking, breastfeeding, and environmental improvements. Limitation of smoking markedly reduces risk for lung cancer, ischemic heart disease, and chronic obstructive pulmonary disease; outside the health sector it reduces (at least to some extent) property damage from fire and frees productive resources for alternative use. Breastfeeding, likewise, has multiple health effects; it enhances child immunity, reduces exposure to infection, provides balanced nutrition and, by suppressing ovulation, postpones the next pregnancy (Anderson 1990). The cost of breastfeeding, however, includes, as do many health-promoting interventions, substantial amounts of mothers' time—which is not easily valued in terms, say, of wages forgone (Leslie 1992). Finally, whereas environmental interventions have beneficial health consequences, their main objectives often lie outside the health sector; World Bank (1992) provides a recent comprehensive discussion.

Appendix table 1A-2 lists a number of public health interventions that have a range of outcomes; in country-specific applications, assessment of the cost-effectiveness of these interventions should, ideally, quantitatively aggregate intervention effects along these multiple dimensions of outcome. Likewise for clinical intervention there will frequently be joint costs (associated, for one example, with the availability of diagnostic facilities in a district hospital); again, in country-specific application, these matters need to be assessed more quantitatively than they can be in a general overview.

Authors of the disease-specific chapters of this collection have generally noted where interventions for the condition they were addressing had multiple outcomes, and in this chapter, I too note the most important cases. It is clear, looking across findings of the individual chapters in this collection, that multiple effect and joint cost problems do complicate the task of assessing cost-effectiveness in many important instances; that said, it is more generally true that these problems are relatively minor or can be dealt with by reasonable approximations and simplifications in the analysis.

Findings

Appendix table 1A-3 presents, in very summary form, the findings from the chapters in this collection concerning public health interventions. For each disease category the first column of appendix table 1A-3 indicates relevant intervention strategies, and the second indicates, to be explicit, the objec-

tive of intervention—primary prevention, secondary prevention, cure, rehabilitation, or palliation (as defined in table 1-2). The first column states findings on cost-effectiveness and, where applicable, notes the most important factors (from table 1-4) likely to lead to variability in cost-effectiveness across circumstances.

Although the entries in appendix table 1A-3 are self-explanatory, a few general observations on each primary category of intervention may be worth making.

PERSONAL BEHAVIOR CHANGE. Some personal behavior changes that are favorable for health outcomes tend to occur naturally as incomes rise; these include, at least for many cultures, improved hygienic behaviors, increased energy intake and quality in the diet, and decreased crowding. Improvements in these behaviors are typically important for the pre-epidemiological transition diseases and, as entries in appendix table 1A-3 indicate, can often be affected by educational interventions even though the main force driving improvements—income increases—is beyond the domain of health policy.

Other behaviors are likely either to be less dependent on income levels (for example, breastfeeding behavior, sexual practices) or to be adversely influenced by income increases, at least for a period of time (for example, dietary excess, sedentary lifestyles, smoking, alcohol consumption). Most of these are risk behaviors for posttransition conditions. Although the natural course of development is unlikely to improve these behaviors, there is more of a scope for affordable government policy to influence them. Regulatory policies and, particularly, taxation policies for tobacco, alcohol, and fatty meats show great promise for inducing behavioral change and, currently, are very much underused. Education of elites and the public are complementary instruments, not least because they generate the political will and popular support for regulation and taxation. The extremely high cost-effectiveness of smoking control makes it, perhaps, the top priority for governmental action (Stanley, appendix A, this collection); although less well documented, the probably high cost-effectiveness of alcohol control makes it another priority.

ENVIRONMENTAL HAZARDS CONTROL. Rising incomes help with improving water supply and sanitation and that is likely to be important in prevention of a broad range of infectious and parasitic diseases. Vector control is at least marginally cost-effective for a number of conditions (malaria, onchocerciasis, dengue) in some environments. Industrialization introduces new hazards into the environment (lead, mercury, and the like) that can produce severe lifetime disability if not effectively controlled. Improvements in household ventilation, indoor fireplaces, and cookstoves can substantially reduce risks for chronic obstructive pulmonary disease (COPD); and occupational and transport safety measures are important in many specific instances. In principle, protective measures can be delivered through environmental intervention, and water fluoridation for prevention of caries is one example. Not

explicitly mentioned in appendix table 1A-3 is the problem of lead toxicity resulting from excess use of lead-based paints and combustion of gasoline with high lead content. Recent research—reviewed in Pollitt (1990)—indicates that lead toxicity may be far more important than previously thought as a determinant of slow development and impaired mental functioning.

IMMUNIZATION, MASS CHEMOPROPHYLAXIS, AND SCREENING. The interventions listed on appendix table 1A-3 under the headings Immunization, Mass Chemoprophylaxis, and Screening all share certain common characteristics: (a) they involve the direct administration or application of a specific technical intervention to individuals on a one-by-one basis, (b) they are directed to certain target populations, and (c) the coverage of the target population is important to produce the desired effect. Technically, each of these intervention strategies is highly efficacious when correctly applied to a compliant subject, but their actual effectiveness in developing-country settings is strongly conditioned by the local administrative, managerial, and logistical capabilities, as well as by traditional cultural constraints.

Although it is no surprise, the all-pervasive potential of immunization programs is dramatically underlined in the findings set forth in appendix table 1A-3.Most immunization interventions are highly cost-effective; and many of them address highly prevalent conditions. Measles and tetanus vaccination appear particularly cost-effective and worthy of relatively greater attention within immunization programs. Far more could be efficiently spent on immunization than is now being spent; and, even though costs of delivery tend to rise as more marginal populations are reached, extending immunization programs to virtually universal coverage is likely to prove both cost-effective and a practical way of significantly improving the health of the poor.

One particularly promising application of mass chemoprophylaxis lies in the administration of anthelmintic medication and micronutrient supplements to school-age children. Here cost-effectiveness appears quite high for conditions that, although of extremely high prevalence, have only recently been seen to be of substantial importance for intellectual and physical development. A program of chemoprophylaxis for school-age children could, like the Expanded Programme on Immunization (EPI) for younger children, be expected to serve as the starting point for an ultimately much expanded capacity to deal with the health needs of this age group; the Rockefeller Foundation and the UNDP are jointly initiating such a program.

Perhaps the only significant cancers for which treatment is cost-effective (breast, cervical) are ones for which early screening and referral are important; so, as NCDs begin to emerge, this strategy will become increasingly relevant. The emerging strategies for treatment of acute respiratory infections in children all rely heavily on community-based programs for early detection and quick referral; with increased experience, improvements in capacity for cost-effective screening and referral programs can be expected to develop.

These comments only touch on some of the findings summarized in appendix table 1A-3 to give a sense of their range and diversity. Next is a discussion of clinical interventions.

The Findings: Clinical Interventions

Facilities to provide clinical intervention vary continuously in size, in the degree of complexity (and range) of the conditions that they address, in the sophistication of their facilities and equipment, and in the training and skill of their staff.[12] The authors have found it useful, nonetheless, to use generally accepted terminology in categorizing facilities into three groups—clinic-level, district hospitals, and referral hospitals—while recognizing that that categorization involves much simplification and that the appropriate classification structure will vary substantially from country to country. Appendix table 1A-4 indicates (in a very general way), for each of these three levels of facility, examples of the kinds of interventions they might address and what capacity such a facility might have for primary modes of diagnostic and therapeutic intervention.

Each chapter of this collection addresses the desirability not only of public health intervention but also of clinical interventions that might be mounted at various levels of the referral system. One lesson that emerges from these chapters is that currently such analyses are severely constrained by the paucity of data relating to the effect and cost of clinical interventions. In the absence of such analyses, it is perhaps natural for developing countries to import, to the extent that resources permit, the methods of case management used or being developed in high-income countries. The key phrase here is, of course, "to the extent that resources permit." Available resources permit importation of high-cost interventions for only a tiny proportion of a developing country's population.[13] In order to extend access to services for the rapidly emerging epidemic of acquired immunodeficiency syndrome (AIDS) as well as for the impending epidemic of noncommunicable disease, radically lower cost methods of case management will need to be developed from the rich range of technologies and procedures that now exist, or that are coming into being.

Appendix table 1A-5 summarizes data from the individual chapters on the cost-effectiveness of clinical intervention, by disease, subject to the caveat that potentially remediable data deficiencies have frequently left a high margin of uncertainty. The table includes discussion, for each condition, of the strategy (level of facility and mode of intervention) for treating it, indicates the objective of intervention, and summarizes findings on cost-effectiveness.

Several observations stand out from appendix table 1A-5:

• Curative care for tuberculosis and sexually transmitted diseases appears extremely cost-effective; further, such care is not now being provided to anything like the extent it should be, given the high burden of morbidity and mortality resulting from these conditions. Surgical treatment of cataract is also highly cost-effective.

- The extremely diverse range of clinical interventions of moderate cost-effectiveness (medical management of angina or diabetes are examples as is surgical management of cervical cancer) suggests that country-specific analyses of these conditions are required and that facilities capable of competently handling diverse conditions will need to be developed.

- The cost is sufficiently high for some clinical interventions to imply that even if they are effective (as is the case with coronary artery bypass grafting to deal with angina), their cost-effectiveness is so poor that their use should be actively discouraged until other, more cost-effective interventions can be delivered to their appropriate potential.

- Control of pain from terminal cancer could benefit perhaps 1.5 million individuals annually at acceptable costs; current legislation and standard practices greatly limit what is done in relation to what potentially could be done.

- Rehabilitation (in particular from leprosy, poliomyelitis, and injury) shows promise of being extremely cost-effective; but very little attention has been accorded rehabilitation, and little is known about how best to provide services on a population basis or what might be expected in terms of effectiveness and cost.

Again, as with the discussion of public health interventions, one theme that emerges from this review of clinical cost-effectiveness is that of complexity and diversity. Many interventions are clearly not cost-effective, and public policy should make every effort to discourage their use. But the available evidence does suggest that a broad range of interventions, addressing a similarly broad range of conditions, will prove cost-effective. Many of these interventions are not now being used to anything like the extent that they should be. Likewise, much of what is currently undertaken by the clinical system is misdirected (toward interventions of low cost-effectiveness) or simply inefficiently used. Redirection of substantial resources from interventions of low cost-effectiveness toward those with very high cost-effectiveness is clearly possible; a central task of health policy must be to design implementation strategies and government policy instruments that can promote these potential efficiency gains.

Conclusions

I draw five very broad conclusions—one methodological and the other four substantive—from this collection reporting on the World Bank's Health Sector Priorities Review. The methodological conclusion is that it is feasible, on a broad scale,

systematically to assess intervention cost-effectiveness in the health sector. The effort required is substantial, but results that allow broad intrasectoral assessment of intervention priorities can be obtained.

One substantive conclusion is that the available evidence points to great variation, across interventions, in marginal cost-effectiveness.[14] Appendix table 1A-6 summarizes this evidence by grouping interventions into ranges of marginal cost per DALY in hypothetical (but realistic) environments. The challenge ahead is that of designing and implementing instruments of government policy that will greatly expand use of the interventions in the first two sections of appendix table 1A-6 while decreasing use of interventions, like those in the last section of the table, that provide very little value for money.

Garber and Phelps (1992) observe, though, that under a reasonable range of assumptions it will make economic sense to pay for DALYs up to a cost of about twice the level of income; this leads to a second substantive conclusion from appendix table 1A-6, which is that, in many countries, quite a broad array of interventions is likely to prove attractive by any reasonable economic standard.

My third substantive conclusion concerns the extent to which public health as opposed to clinical strategies tend to be more cost-effective and the extent to which seeking primary preventive objectives will tend to be more cost-effective than seeking other objectives. Appendix tables 1A-7 and 1A-8 summarize the material from appendix table 1A-6 in ways that allow these questions to be addressed. Although there are some patterns (in particular, primary prevention by way of immunization accounts for many highly cost-effective interventions), in general I conclude that there is no especially strong general tendency for primary prevention or public health interventions to have superior cost-effectiveness.

The fourth substantive conclusion is that virtually no cost-effective interventions require more specialized facilities than those available at district hospitals. Thus, even though one cannot argue in general in favor of prevention over cure or public health over clinical intervention, one *can* conclude that district hospitals and lower level facilities potentially offer almost all attractive interventions.

Appendix 1A: Clinical and Public Health Interventions

The eight tables in this appendix examine clinical and public health interventions and relate the characteristics of the different interventions to their cost-effectiveness.

Table 1A-1. Public Health Interventions

Intervention strategy	Adverse health outcomes avoided or treated
	Promoting healthy behavior
Dietary practices	
Maternal	Low birth weight
Infant/child	Growth-stunting infection, micronutrient deficiency
Adult	Obesity, diabetes, cancer, ischemic heart disease, hypertensive disease
Prevention against infection	
Personal hygiene	Diarrheal diseases, intestinal parasites, skin infections
Use of soap	
Food handling	
Defecation practices	
Household ventilation/crowding	Respiratory diseases
Sexual behaviors	Sexually transmitted diseases, premature fertility
Personal health practices	
Exercise	Obesity, heart disease
Stress control	Mental disease
Carelessness	Injuries, poisoning
Tobacco use	Cancer, heart disease, chronic obstructive pulmonary disease
Controlling substance abuse	
Alcohol	Hypertensive disease, cirrhosis, injuries
Drugs	Addiction, injuries, mental disease
Preventing intentional mutilation	Injuries
Reproductive practices	
Contraceptive practice	Unwanted pregnancy
Pregnancy care	Pregnancy outcome
Childbirth practice	Perinatal/maternal mortality
Breastfeeding practice	Malnutrition, diarrhea
Abortion	Maternal mortality, unwanted pregnancy
Home care	
Use of first aid	Injury
Use of oral rehydration therapy	Diarrheal disease, acute diabetic conditions
Clinic use	
Treatment of simple conditions	Entry into referral structure
	Control of environmental hazards
Household	
Water availability/quality	Water-related diseases
Waste disposal	Infectious diseases, toxic exposures
Food hygiene	Diarrhea, parasites
Air quality	Respiratory disease
Vector control	Malaria, yellow fever, river blindness
Community	
Housing quality	Injury, poisoning
Motor vehicle/road safety	Accidents, injuries
Occupational hazard control	Injury, toxic exposure
	Public health services
Immunization	
At birth	Hepatitis B, tuberculosis
First year of life	Polio, measles, diphtheria, tetanus, pertussis
School age	Tetanus
Adulthood	Tetanus, yellow fever, influenza
Mass chemoprophylaxis	
Food fortification	Iodine and other deficiencies
Micronutrient supplementation	Vitamin A and other deficiencies
Water fluoridation	Caries
School-based provision of anthelmintics	Schistosomiasis, intestinal helminths
Mass administration of antibiotics	Sexually transmitted diseases
Screening and referral	
Screening programs in clinics, schools, work sites, and so on	Selected infectious diseases (such as tuberculosis); cancers (such as cervix, breast); cardiovascular disease risk factors (such as hypertension, hyperlipidemia); high-risk pregnancy

Source: Author.

Table 1A-2. Selected Interventions with Multiple Outcomes

Intervention	Outcome		
	Main health outcome	*Secondary health outcome*	*Nonhealth outcomes*
Provision of water supplies and sanitation	Control of diarrheal diseases	Control of skin, respiratory, and helminthic infections	Saving of household time; welfare improvements
Provision of soap	Control of diarrheal diseases	Control of skin, respiratory, and helminthic infections	
Reduction of vehicle speed limits	Reduced severity and incidence of crash-related injuries		Reduction in property damage from vehicle crashes; energy conservation; time costs
Control of smoking	Reduced incidence of lung cancer, heart disease, and chronic obstructive pulmonary disease	Reduced incidence of minor cancers; reduction in burn injuries	Welfare loss for current addicts, welfare gain for nonsmokers; freeing of land and labor for uses other than tobacco production
Vector control	Reduced incidence of vector-borne diseases		Improved welfare when vectors, such as mosquitoes, are nuisances
Female education	Reduced child mortality rates	Improved child growth; reduced adult health	Higher levels of female productivity and earnings; improved congruence between actual and desired fertility levels
Breastfeeding	Improved child growth through improved nutrient availability and protection against diarrhea	Protection of child against infectious disease; postponement of next pregnancy; possible long-term cognitive benefits to child	Savings in costs of infant formula and bottles; time costs for mother
Family planning services	Reduced child mortality	Reduced maternal morbidity and mortality	Economic and welfare gains from improved control of level and timing of fertility

Source: Author.

Table 1A-3. Public Health Interventions: Cost and Effectiveness

Condition	Intervention strategy	Objective	Cost and effectiveness	Comments
Acute respiratory infections (ARI) (see chap. 4)	*Screening and referral:* households need to be educated to identify signs of pneumonia in children and bring them to clinics for treatment	Cure	Costs per disability-adjusted life-year (DALY) $20 in high-mortality environments to $50 in low-mortality environments	Has variable efficacy in all age groups. See ARI case management chapter for details of program
	Behavior change: breastfeeding promotion via education programs	Secondary prevention (via strengthening of child to reduce effects of infection)	Approximately $50 per DALY (for ARI consequences of breastfeeding only)	Multiple benefits, including averted infant mortality
	Reduced protein-energy malnutrition via supplementation programs	Secondary prevention (via strengthening of child to reduce effects of infection)	Estimated cost per DALY about $65	Depending upon food availability
	Immunization: for pertussis, see discussion of poliomyelitis; Pneumococcal vaccine	Primary prevention	For appropriate age groups (> 18 mo.), cost per DALY saved about $70	Has variable efficacy for all age groups
	For measles, see that entry Hemophilus influenzae vaccine	Primary prevention	No estimates available for cost-effectiveness; vaccine costs high, $2 to $14 per dose. Moderate efficacy in children over two years	Efficacy trials in early stages
Diarrheal diseases (see chap. 5)	*Possible immunizations:* using effective rotavirus vaccine	Primary prevention	Approximately $10 per DALY, assuming 80 percent vaccine efficacy	Effective vaccine still not available
	Using effective cholera vaccine	Primary prevention	Approximately $75 per DALY, assuming 70 percent vaccine efficacy	Current vaccines have low efficacies
	Immunization: measles vaccine	Primary prevention	Approximately $10 per DALY, assuming 85 percent vaccine efficacy	Rotavirus and measles-associated diarrhea is much more common than cholera, explaining much of the cost-effectiveness differences
	Control of environment: improving water supply and sanitation by upgrading of infrastructure	Primary prevention	Cost-effectiveness of diarrhea averted is unknown, but there are additional benefits	Estimated to reduce diarrhea morbidity and mortality by about 30 percent
	Behavior change: improved domestic and personal hygiene via education	Primary prevention	Approximately $170 per DALY, depending on case-fatality reductions, incidence rates, and wage levels	
	Breastfeeding promotion by various methods, including changes in hospital routine and mass-media education	Primary prevention	Approximately $30 per DALY, assuming a reduction in non-breastfeeding of 40 percent (< 2 months), 30 percent (3–5 months) and 10 percent (6–11 months) and assuming a judicious selection of interventions used	See above
	Improving weaning practices by education	Secondary prevention	Approximately $30 per DALY, in children < 75 percent weight-for-age, age six months to five years	See above

Table 1A-3 (continued)

Condition	Intervention strategy	Objective	Cost and effectiveness	Comments
Poliomyelitis (see chap. 6)	*Immunization:* oral or injectable polio vaccine in three or more doses to children under one year of age; given simultaneously with diphtheria, pertussis, and tetanus DPT immunization	Primary prevention; established a global objective: eradication of disease from wild polio virus by the year 2000	For polio plus DPT, cost per DALY approximately $20 in high-mortality environments and $40 in low-mortality environments; cost per DALY of DPT without polio vaccine somewhat higher and cost of polio without DPT immunization many times higher	If injectable used, there could be a reduced number of needed contact raising immunization rates and costs per fully vaccinated child in some environments
Helminthic infection (see chap. 7)	*Targeted mass chemotherapy:* school-based delivery of anthelmintics (praziquantel for schistosomes and albendazole for intestinal helmintics in high-endemicity areas without individual screening)	Secondary prevention	Ranging from $6 to $33 per DALY; low estimate assumes either 0.02 or 0.2 DALYs saved yearly and high estimate assumes either 0.05 or 0.5 DALYs saved yearly. Approximately 80 percent effectiveness and heavily reliant on intensity of infection	Cost-effectiveness figures are hypothetical, using range of program costs and empirical estimates of efficacy
	Targeted screening and treatment: praziquantel and albendazole given after screening in targeted groups	Secondary prevention	Depending upon intensity of infection	Generally two-thirds as effective at same cost as mass or targeted chemoprophylaxis
	Control of environment: onchocerciasis vector control with chemical pesticides	Primary prevention	$100–$200 per DALY saved, and closely tied with breeding patterns of vector	Variable efficacy in trials
	Cloth filters for crustacean intermediate of Dracunculus (guinea worm)	Primary prevention	Probable low cost	Only enclosed water supplies will eradicate disease
Measles (see chap. 8)	*Immunization:* four possible scenarios: • the current antigen at nine months of age • the above plus coverage at all "opportunities" • the E-Z antigen at six months • the E-Z antigen at six months and nine months	Primary prevention via individual protection; with high vaccination coverage rates, some protection resulting from interruption of transmission	With use of the current measles antigen at the recommended nine months of age, base cost per DALY gained $2 to $15, depending on case-fatality rates and cost of the measles portion of the program. Epidemiologic model to assess effectiveness of alternative antigens and two-dose schedules demonstrates that significantly more deaths could be averted over the base cost at costs per incremental DALY of twice the cost per DALY of the base case—still relatively attractive	Vaccination should begin earlier in life in areas with high measles mortality. This change in vaccination schedule would alter cost-effective figures
Tetanus (see chap. 9)	*Immunization:* routine vaccination targeting women of childbearing age, and pregnant women, schoolgirls, infants, and males	Primary prevention	Approximately $2–10 per DALY gained, predominantly from averted neonatal tetanus mortality. Depends on incidence rates, which in turn are tied with health infrastructure, especially birth practices	Choice of strategy and target group varies according to incidence, available resources, health service organization, channels for contact, immediacy of desired impact, and so on
	Behavior change: training birth attendants	Primary prevention	Suspected to be higher than costs for routine vaccination of pregnant women	Training, supervision, and support costs may be too high for much of the developing world

Rheumatic heart disease (see chap. 10)	*Immunization:* to prevent incidence of rheumatic fever/rheumatic heart disease (RF/RHD) precursor, group A streptococcus	Primary prevention	Possible low cost	Vaccine under development; unlikely to be available for many years
	Screening and referral: for children with pharyngitis refer to clinic for antibiotic prophylaxis against RF	Primary prevention of RF	Cost about $300 per DALY; high because proportion of pharyngitis cases that develop into RF is low	May encounter resistant strains, necessitating expensive antibiotics
Tuberculosis (see chap. 11)	*Immunization:* BCG added to DPT program	Primary prevention	$7 per DALY; cost-effectiveness drops substantially when annual risk of infection < 1 percent	Reported effectiveness of vaccine is widely variable. Costs of BCG program alone are four times those of adding it to preexisting EPI
	Targeted chemoprophylaxis: selective screening in high-risk populations (AIDS patients and family members of tuberculosis patients) and treatment of smear-positive patients	Primary and secondary prevention	Suspected to be reasonable	Mass prophylaxis has high costs with limited effectiveness
Leprosy (see chap. 12)	*Immunization:* use of BCG vaccine to prevent leprosy	Primary prevention	Probably reasonable, as costs be shared with tuberculosis immunization program. Will depend on incidence rates	Vaccine reported to be 30–80 percent effective against leprosy, depending on age at vaccination and regions studied
	Targeted screening: passive screening via clinical exam	Primary prevention	$0.50 per DALY, sensitive to percentage of cases which are multibacillary or paucibacillary (harder to diagnose clinically) and incidence rates	Does not include treatment costs (see appendix table 1A-5)
Malaria (see chap. 13)	*Control of environment:* chemical vector control via intradomicillary spraying of insecticide to kill adult mosquitoes	Primary prevention	$5–$250 per DALY, depending on type of mosquito which is the primary determinant of case fatality. Also linked with incidence rates and geographical distribution of the human and mosquito population	If population widespread, the marginal costs of eradication are high. Cost-effectiveness will decrease if spraying is carried out in nonuniform manner
	Environmental vector control via drainage and land management techniques	Primary prevention	Suspected to be high	Role limited to urban areas. Chemically impregnated bed netting with promising results
Dengue (see chap. 14)	*Control of environment:* spraying of chemical insecticide for Aedes mosquito	Primary prevention	$2,200 per DALY tied to how quickly Aedes replaces itself	Has to be repeated several times per year
	Direct expenditures and education for eliminating breeding sites of Aedes mosquito	Primary prevention	$3,500 per DALY needs integrated program to be effective	Closely related to labor costs. Has potential of sustained long-term control or eradication
	Possible immunization: two-dose vaccination will probably be needed	Primary prevention	$1,600 per DALY heavily dependent on incidence rates	Vaccine in planning stages

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(Table continues on the following page.)

Condition	Intervention strategy	Objective	Cost and effectiveness	Comments
Hepatitis B (see chap. 15)	*Immunization:* adding three dose vaccine to preexisting immunization program	Primary prevention	$25–$50 per DALY depending on prevalence of carrier state and ability of immunization program to provide adequate coverage using a three-dose schedule	Discounting of benefits is important, since vaccine is given at birth and averted mortality occurs late in life. Cost of treating significant morbidity important (especially cirrhosis). Vaccine costs are variable but have declined significantly for public sector programs. Maximum cost-effectiveness may be achieved only through integration into routine infant immunization programs
Excess fertility (see chap. 16)	*Behavior change:* increasing the use of condoms via education and subsidization	Primary prevention	$15–$75 per DALY will vary depending on number of births which exceed the resources of a family or society and the mortality associated with this excess. The effectiveness of the program is an essential component which will rely on personal acceptance of condoms	Only includes benefits derived from averted mortality by increasing birth interval and limiting teenage pregnancies. Assumes theoretical 100 percent effectiveness
	Use of information, education, and communication model to lengthen birth intervals by encouraging breastfeeding	Primary prevention	Suspected to be of low to moderate cost and is dependent upon cultural biases	Benefits from averted ARI and diarrhea cases in breastfed child are significant
Maternal and perinatal health (see chap. 17)	See entry in appendix table 1A-5			
Protein-energy malnutrition (see chap. 18)	*Targeted mass chemoprophylaxis:* food supplementation for preschool children resulting in a 100,000-calorie transfer and 0.5-kg average weight gain	Secondary prevention	$70 per DALY, based on relationship between food supplementation and child growth for particular weight-for-age child	Depends on percentage of target population that are severely or moderately malnourished, since standard food transfer will affect these groups differently
	Food supplementation for pregnant women resulting in a 100,000-calorie transfer and a 300-gram increase in birth weight	Secondary prevention	$25 DALY, based on relationship between food supplementation and fetal growth as it affects infant mortality	See above
Micronutrient deficiency disorders (see chap. 19)	*Targeted mass chemoprophylaxis:* daily self-administered oral iron supplementation for duration of pregnancy	Secondary prevention	$13 per DALY, depending on prevalence rates and severity of iron deficiency anemia	In regions of severe iron deficiency anemia
	Use of injected or oral iodinated oil once every two to five years in women of reproductive age	Secondary prevention	$20 per DALY varies with prevalence rates and severity of iodine deficiency	Clean syringes need to be used
	Semiannual mass dose of vitamin A for children age zero to five	Secondary prevention	$9 per DALY varies with prevalence rates and severity of vitamin A deficiency	Benefits include averted measles, respiratory and diarrheal mortality

	Mass chemoprophylaxis: fortification of salt or sugar supplies with iron-containing compounds	Secondary prevention	$5 per DALY varies with prevalence rates and severity of iron-deficiency anemia	As with all food fortification programs, the carrier must be available and accepted by the groups at risk
	Iodization of salt or water	Secondary prevention	$8 per DALY, depending on prevalence rates and severity of iodine deficiency	See above
	Fortification of sugar with vitamin A compounds	Secondary prevention	$5 per DALY, depending on prevalence rates and severity of vitamin A deficiency	See above
HIV infection and other sexually transmitted diseases (see chap. 20)	*Screening and referral:* blood screening for HIV among blood donors using rapid lab tests	Primary prevention	$1–$250 per DALY linked to the prevalence rate of HIV infection among blood donors and sexual activity group of proposed blood recipient	Cost of blood test relies on sophistication of health care system
	Behavior change: information, education, and communication program to: (a) decrease frequency of sexual partner change, and (b) increase proportion of sex acts protected by condoms	Primary prevention	$1–$150 per DALY depends on sexual activity and prevalence of each type of sexually transmitted disease in target population (i.e., HIV transmission rates in population with syphilis greater than in population with chancroid)	Social barriers to condom usage are often important. Practical problems include the identification of the "access group" by which high-risk groups can be identified
	Female education and employment: reduce supply of female sex workers by raising their opportunity cost and reduce demand for their services by attracting more women to urban areas	Primary prevention	Likely to be highly effective in the long run and may yield many benefits other than disease control	Cost-effectiveness difficult to compute
Cancers (see chap. 21)	*Screening and referral:* use of PAP smear at five-year intervals to screen for cervical cancer	Secondary prevention	$100 per DALY, based on prevalence rates and health care setting in which program is carried out	Assumes that there will be an appropriate referral system for further treatment if indicated by PAP smear
	Annual breast examinations to screen for breast cancer	Secondary prevention	$50 per DALY based on prevalence rates and health care setting in which program is carried out	Same as above and use of annual mammography at one-year intervals for women fifty-nine and above reduces cost-effectiveness tenfold
	Behavior change: smoking cessation classes	Primary prevention	$20 per DALY tied to percentage of antismoking effort aimed at preventing "new starters" or those already smoking	Less expensive to prevent onset of smoking than to have smokers quit
	Smoking reduction via tobacco tax	Primary prevention	See COPD entry in this table	See COPD entry in this table
Diabetes (see chap. 22)	*Behavior change:* health education to improve dietary and exercise habits may hold potential for prevention of non-insulin-dependent diabetes (NIDDM)	Primary prevention of NIDDM	Costs might be $0.02 to $0.50 per capita per year; effectiveness unknown but probably low. Cost-effectiveness enhanced by similarity of the behavior changes for reducing cardiovascular and some cancer risks	NIDDM patients often have limited modification program rates
	Screening and referral: screening for glucose intolerance in high-risk groups (such as obese, pregnant women) may allow for more precise targeting of health education and perhaps medication	Primary and secondary prevention of NIDDM	Unknown; cost-effectiveness depends on prevalence in the screened group and cost-effectiveness of referred interventions	High costs associated with complication (stroke, coronary artery disease, ketoacidosis, and coma)

(Table continues on the following page.)

Table 1A-3 (continued)

Condition	Intervention strategy	Objective	Cost and effectiveness	Comments
Cardiovascular disease (see chap. 23)	*Behavior change:* through a public prevention package (mass education and individual counseling); screening and referral services to those at high risk	Primary and secondary prevention	Costs perhaps less than $1 per capita per year in targeted population, about $150 per DALY	Effectiveness will depend on depth of impact.
Chronic obstructive pulmonary disease (see chap. 24)	*Behavior change:* smoking reduction via tobacco tax and education/cessation programs	Primary prevention	20 percent tax on tobacco might reduce overall tobacco consumption by about 20 percent and avert perhaps 40 deaths per year in a typical population of 200,000 smokers. Adding educational programs, $20 per DALY can be achieved	Heavy smokers (those with greatest risk) may be unresponsive to program
Injury (see chap. 25)	Alcohol taxation to discourage use resulting in 30 percent decrease in fall, transportation, and burn injuries	Primary prevention	Low to moderate cost per DALY depends on case-fatality rates and percentage of injuries that are alcohol attributable	If public is strongly against an alcohol tax, illicitly produced alcohol use may increase, resulting in excess mortality
	Education programs to reduce transportation, burn, and poisoning injuries by 40–50 percent	Primary prevention	Moderate cost per DALY depends on depth of impact and case-fatality rates	Injury education programs have limited effectiveness without safety laws. Alcohol awareness component often essential
	Control of environment: manufacture, modification, and use of products such as seat belts, safer stoves, and childproof caps to cause a 50 percent reduction in transportation, fall, burn, and poisoning injuries	Primary prevention	High cost per DALY depends on case-fatality rates and percentage of injuries which are preventable by environmental improvements	Safer product will still have to be inexpensive and some improvements will require enormous fixed costs
Cataract (see chap. 26)	*Behavior change:* ocular protection from solar radiation (e.g., hats and sunglasses)	Primary prevention	Inexpensive depending upon extent to which cataract progression is retarded by eye protection	Probably beneficial, but to what extent is unknown
Oral health (see chap. 27)	See appendix table 1A-5			
Schizophrenia and manic-depressive illness (see chap. 28)	See appendix table 1A-5			

Source: See chapters on individual diseases in this collection.

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Table 1A-4. Clinical Intervention: Level of Facility and Mode of Intervention

Level of clinical facility	Typical conditions addressed	Intervention mode			
				Therapeutic	
		Diagnostic	Medical	Surgical	Physical or psychological therapy
Clinic (private, community, and school- and work-based)	Minor trauma; simple injections; support of population-based interventions; uncomplicated childbirth; family planning	·Clinical	Short list of essential drugs (about 20)	Sutures	Important potential role for supervisng physical therapy
District hospital	Complicated childbirth fractures and burns; complicated infections; cataract; hernia; appendectomy; diabetes, hypertension, and similarly complex condition	Clinical; basic laboratory; basic radiologic facilities	Long list of essential drugs (about 200)	Capacity for dealing with abdominal surgery, many fractures, cesarean sections, some rehabilitative surgery	Design and management of more complex regimens of physical and psychological therapy
Referral hospital	More complicated medical and surgical conditions	More advanced laboratory and radiologic facilities	As above, but also specialized drugs, chemo-therapy, and radiotherapy	As above but also capacity for more complicated surgery of head and chest	Support capacity for district hospitals

Source: Author.

Table 1A-5. *Clinical Interventions: Cost and Effectiveness*

Condition	Intervention strategy	Objective	Cost and effectiveness	Comments
Acute respiratory infections (see chap. 4)	*Clinic level:* antibiotic treatment of pneumonia in young children (for whom case-fatality rates high). To succeed, control programs must educate families to bring children with cough or difficulty breathing to a facility quickly	Cure	Costs per disability-adjusted life-year (DALY) saved is $20 in high-mortality to $50 in low-mortality environments	Resistance to "first line" antibiotics will necessitate use of expensive antibiotics. Costs of allergic reaction to medication could be substantial.
Diarrheal diseases (see chap. 5)	*Clinic level:* education and distribution of ORT sugar-salt solution	Secondary prevention	Ranging from $35–$350 per DALY, depending on the case-fatality rate of target population and the cost of labor	Assuming cost per diarrhea of $1.00–$5.00 and 0.05%–0.5% of deaths prevented per case treated
	Use of antibiotics and antimotility agents	Curative	Very poor cost-effectiveness for most diarrhea cases for which they are either harmful or useless	May be indicated for dysentery or cholera
Poliomyelitis (see chap. 6)	*Clinic level:* physiotherapy, psychotherapy, provision of simple prostheses to enhance physical function and promote social integration	Rehabilitation	Potential high cost per DALY	Needs constant source of skilled labor
	District and referral hospital levels: surgery of varying degrees of complexity	Rehabilitation	Probable moderate to low cost per DALY	Developed health care system and expensive specialists when needed
Helminthic infection (see chap. 7)	See entry in appendix table 1A-3			
Measles	*Clinic level:* therapeutic doses of vitamin A for children with severe measles; other therapy (including use of antibiotics) to further reduce adverse consequences	Secondary prevention	Limited evidence that case-fatality rates can be reduced by 50 percent or more from their initial levels of 0.01–0.05. If such therapy costs $10, cost per DALY of therapy would be $20–$80	Proportion of measles morbidity and mortality which is preventable via supplementation is still being investigated
Tetanus (see chap. 9)	*Referral hospital level:* case management care including neurorespiratory resuscitation; antispasmodic therapy; antitoxin drugs, wound care, and intensive nursing	Cure	$100 per DALY and is tied to case-fatality reduction	Needs moderately sophisticated health care system, wide range in protocol costs. Few neonatal tetanus patients are brought for medical care.
Rheumatic heart disease (see chap. 10)	*Clinical level:* regular administration of antibiotics at three- to four-week intervals prevents recurrence in patients who have had rheumatic fever (RF), later bouts of RF, hence emergence of rheumatic heart disease	Secondary prevention	$100–$200 per DALY in compliant patients	Compliance is an issue
	Referral hospital level: open-heart surgery in higher-level referral hospitals to permit restoration of function in mitral or other valves (valvuloplasty)	Secondary prevention and rehabilitation	$1,000–$2,000 per DALY, depending on age of patient and local surgical costs	Needs advanced health care system

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	Intervention	Level	Cost	Comments
Tuberculosis (see chap. 11)	*Clinic level:* short-course chemotherapy with two-month hospitalization	Cure Primary prevention	$3 per DALY linked to hospitalization costs. Standard chemotherapy has lower drug costs, but a lesser cure rate compared with short-course chemotherapy (with similar hospitalization periods)	Resistant strains could become a significant problem (especially among AIDS patients) causing an increase in costs
Leprosy (see chap. 12)	*Clinic level:* multidrug therapy with monthly visits to health center and daily oral medication	Cure	$7 per DALY will depend on percentage of cases which are multi- or paucibacillary since the latter has much higher treatment costs. Does not include benefits of decreased transmission	Compliance with daily oral medication and drug resistance needs to be considered in detail. Does not include screening costs (see appendix table 1A-3) or capital costs ($3 per DALY)
	District hospital level: treatment of complications, including reconstructive surgery, ulcer therapy, and alternate medication	Rehabilitation	$190 per DALY, depending on level of services provided	Sensitive to labor and hospital costs
Malaria (see chap. 13)	*District level:* treatment of passively detected malarial patients in regions of moderate-to-high endemicity and chemical vector control	Cure Primary prevention	$200–$500 per DALY tied to case-fatality rates and levels of endemicity	See appendix table 1A-3 for chemical vector control data. Active case searches are expensive and drug resistance may be a problem if antimalarials are used haphazardly
Dengue (see chap. 14)	*District or referred hospital levels:* Improved case management with better education of physicians, lab facilities, and pharmacies	Cure Palliation	$630 per DALY, tied to status of health care system	Difficult to define shared costs. Possible only in countries with system as defined
	Improved case management and possible immunization	Cure Palliation Primary prevention	$1,250 per DALY saved	See appendix table 1A-3
	Improved case management and chemical vector control	Cure Palliation Primary prevention	$1,200 per DALY saved	See appendix table 1A-3 for chemical vector control data
	Improved case management and environmental vector control	Cure Palliation Primary prevention	$3,400 per DALY saved	See appendix table 1A-3 for environmental vector control
Hepatitis B (see chap. 15)	See cancer entry in this table			
Excess fertility (see chap. 16)	*Clinic level:* insertion of intra-uterine (IUDs) and oral contraceptives (OCPs) disbursement	Primary prevention	$30–$150 per DALY saved	While the initial cost of an IUD will be greater than the initial OCP outlay, the amortized IUD cost (over its lifetime) is lower
Maternal and perinatal health (see chap. 17)	*Clinic and district hospital level:* improving the community-based outreach system which provides prenatal and birth attendant care. Upgrading building facilities to ensure safe deliveries (including surgical capabilities)	Primary prevention	Approximately $30–$250 per DALY linked to level of services provided, reductions in maternal/perinatal death rates and number of low-birth-weight babies prevented via the intervention	Calculations are theoretical. Family planning may be added in areas of low contraceptive prevalence

(Table continues on the following page.)

Table 1A-5 (continued)

Condition	Intervention strategy	Objective	Cost and Effectiveness	Comments
Protein-energy malnutrition (see chap. 18)	*District and hospital level:* treatment with feeding for child, education of mothers, and medication for infections	Rehabilitation	Approximately $150–$250 per DALY tied to case-fatality reduction and level of services provided	Cost-effectiveness figures are still theoretical
Micronutrient deficiency disorders (see chap. 19)	*Clinic level:* blood transfusion of severely anemic patients (especially pregnant women prior to delivery)	Cure	Moderate-to-high cost per DALY, depending on case-fatality reduction from transfusion	All blood has to be tested for HIV and hepatitis, which will raise costs
HIV infection and other sexually transmitted diseases (see chap. 20)	*Clinic level:* use of ophthalmic antibiotic ointment at birth to prevent gonococcal ophthalmia neonatorum	Primary prevention	$5–$125 per DALY with lower values at higher prevalence rates	Ointment easily applied and usually requires one dose
	Treatment of sexually transmitted diseases with antibiotics	Cure Primary prevention	$1–$55 per DALY. Most cost-effective interventions are those targeted at most sexually active group in an HIV epidemic	Cost-effectiveness linked to health care setting
	Clinic and district hospital level: treatment of AIDS with medical and surgical interventions	Palliation	$80–$1,250 per DALY, depending on level of services provided, with lower costs for home care and higher costs for antivirals	Unreliable decreases in morbidity with use of antivirals
Cancers (see chap. 21)	*Referral hospital level:* case management treatment of various cancers via surgery, supportive care, and chemotherapy	Cure Palliation	Cost per DALY as follows: leukemia—$10,000; cervix—$2,600; breast—$3,100; lung—$12,000; liver—$11,000; colon and rectum—$5,000; stomach—$10,500; esophagus—$10,600; mouth and pharynx—$3,700; depends on improvements in case-fatality rates	$150 per DALY when program is confined to pain relief. With the exceptions of early stage oral, cervix, breast, and rectum, technically advanced treatment with high foreign exchange content is needed for most cures
Diabetes (see chap. 22)	*Clinic level:* oral hypoglycemics to stabilize non-insulin-dependent diabetes mellitus (NIDDM); concomitant health education	Secondary prevention	Cost of outpatient provision of oral hypoglycemics about $25 per patient per year; can be quite effective in forestalling complications, including insulin-dependent diabetes (IDDM)	Limited compliance rates reported with long-term use of daily medication
	Injected insulin and health education for IDDM	Secondary prevention	Cost of insulin therapy (life-saving) about $210 per year; estimated cost per DALY about $240	The misuse of insulin could lead to excessive morbidity and mortality
Cardiovascular disease (see chap. 23)	*Primary care level:* medical management of hypertension	Secondary prevention	Cost per DALY gained about $2,000 for typical case, linked to mortality reduction	Medication costs often expensive
	Medical management of hypercholesterolemia	Secondary prevention	Cost per DALY gained about $4,000 in typical case, linked to mortality	See above

Disease	Intervention	Type	Cost	Comments
	Medical management of stable angina	Secondary prevention Rehabilitation	Cost per DALY gained $100–$200	
	Management after stroke or myocardial infarction (MI) by behavioral change and appropriate medication	Secondary prevention	Cost per DALY gained $150–$200, tied to disability and mortality reductions	Depends on level of service provided and costs of medication
	District hospital level: low-cost management of unstable angina acute MI	Secondary prevention Rehabilitation	Cost per DALY gained approximately $150–$350	With all cardiovascular interventions
	High-cost management of unstable angina or acute MI	Secondary prevention Rehabilitation	Perhaps $30,000 per DALY saved	Needs advanced health care system
	Referral hospital level: angioplasty or bypass graft surgery	Secondary prevention Rehabilitation	Over $5,000 per DALY gained	See above
Chronic obstructive pulmonary disease (see chap. 24)	*District hospital level:* treatment of exacerbation, including mechanical ventilatory assistance, steroids, and fluids	Palliation	Approximately $200–$300 per day for treatment in hospital with a minimal effect on mortality rates	Needs advanced health care system
Injury (see chap. 25)	*District or referral hospital level:* treatment of injuries including medical and surgical interventions	Cure Rehabilitation	Probably expensive, since based on types of injuries treated	Very difficult to estimate cost-effectiveness, as it depends on levels of treatment
Cataract (see chap. 26)	*Clinic level:* use of fixed surgical facilities, mobile surgical teams, or eye camps to provide unilateral or bilateral cataract extraction	Cure	$20–$40 per DALY. Some variation expected, depending on societal and personal perception of disability from blindness	Includes costs for glasses every five years
Oral health (see chap. 27)	*Clinic level:* plaque and calculus removal, fissure sealants, and topical fluoride. Extraction of teeth with advanced caries	Secondary prevention Cure	Cost per treatment episode could range between $5 and $20. Cost per DALY saved will depend on number of cases treated to prevent one advanced case of caries and is suspected to be moderately high, since there is no mortality burden. Costs also very sensitive to who is performing intervention; preventive care may also be done with lower costs	Pain and inability to chew as a result of advanced untreated caries causes significant disability. Societal demand for dental procedures often high. Fluoridation of water supply requires advanced supply system. Identification of high-risk groups may be effective in reducing costs
Schizophrenia and manic-depressive illness (see chap. 28)	*Clinic level:* use of antipsychotic medication to treat schizophrenic patients with additional use of lithium to treat manic-depressive patients.	Rehabilitation	Cost per DALY gained is $250–$300 for either the schizophrenia or manic-depressive treatment program. Highly sensitive to clinical/societal perception of disability	Clinical training of health center staff, outreach, and compliance components of case are important.

Source: See chapters on individual diseases in this collection.

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Table 1A-6. Intervention Characteristics and Cost-Effectiveness

Potential intervention	Strategy	Objective application	Potential group[a]	Age
$25 per DALY[b]				
Breastfeeding promotion	Public health: Behavior change	Secondary prevention	Moderate	Childhood
Diphtheria-pertussis-tetanus plus polio immunization	Public health: Immunization	Primary prevention	Substantial	Childhood
Measles immunization	Public health: Immunization	Primary prevention	Substantial	Childhood
Tuberculosis immunization	Public health: Immunization	Primary prevention	Moderate	Childhood
Iodization of salt	Public health: Mass chemoprophylaxis	Secondary prevention	Substantial	All ages
Fortification of sugar with vitamin A	Public health: Mass chemoprophylaxis	Secondary prevention	Substantial	Childhood
Semiannual mass dose of vitamin A	Public health: Mass chemoprophylaxis	Secondary prevention	Substantial	Childhood
Rotavirus immunization	Public health: Immunization	Primary prevention	Limited	Childhood
Hepatitis B immunization	Public health: Immunization	Primary prevention	Substantial	Childhood
Medical treatment of measles with vitamin A	Clinical: Primary care	Cure	Limited	Childhood
Medical treatment of acute respiratory infections with antibiotics	Clinical: Primary care	Cure	Moderate	Childhood
Use of ophthalmic ointment at birth to prevent gonococcal infection	Clinical: Primary care	Primary prevention	Substantial	Childhood
Targeted mass anthelmintics	Public health: Mass chemoprophylaxis	Secondary prevention	Substantial	School age
Antituberculosis chemotherapy with short-course hospitalization	Clinical: District hospital	Cure	Substantial	All ages
Smoking prevention or cessation programs	Public health: Behavior change	Primary prevention plus secondary prevention	Substantial	Adults
Use of condoms to prevent excess births and sexually transmitted diseases	Public health: Behavior change	Primary prevention	Moderate	Adults
Blood screening for HIV	Clinical: District hospital, Referral hospital	Primary prevention	Limited	Adults
Iodine injections for pregnant women	Public health: Mass chemoprophylaxis	Secondary prevention	Substantial	Adults
Daily oral iron for pregnant women	Public health: Mass chemoprophylaxis	Secondary prevention	Limited	Adults
Cataract removal	Clinical: District hospital	Cure	Substantial	Elderly
Medical treatment of leprosy	Clinical: Primary care	Cure	Moderate	Adults
Malaria control with chemical pesticides	Public health: Environmental	Primary prevention	Moderate	All ages
$25–$75 per DALY				
Pneumococcal immunization	Public health: Immunization	Primary prevention	Moderate	All ages
Use of oral rehydration solutions	Public health: Behavior change	Secondary prevention	Substantial	School age
Improved weaning practices	Public health: Behavior change	Secondary prevention	Moderate	Childhood
Food supplements for children	Public health: Mass chemoprophylaxis	Secondary prevention	Limited	School age
Food supplements for pregnant women	Public health: Mass chemoprophylaxis	Secondary prevention	Limited	Adults
Improved antenatal care by upgrading facilities and providing family planning	Clinical: Primary care, District hospital, Referral hospital	Primary prevention	Limited	Adults
$75–$250 per DALY				
Medical treatment of tetanus	Clinical: District hospital	Cure	Limited	Childhood
Cholera immunization	Public health: Immunization	Primary prevention	Limited	Childhood
Malaria control with passive case finding and chemical pesticides with treatment	Clinical: Primary care, Public health, Environmental	Primary prevention plus cure	Moderate	All ages

Medical and surgical treatment of leprosy complications	Clinical: Primary care, District hospital	Rehabilitation plus palliation	Limited	All ages
Antibiotic prophylaxis for children with history of rheumatic fever	Clinical: Primary care	Secondary prevention	Limited	Childhood
Public preventive package for most cardiovascular risk factors	Public health: Behavior change	Primary prevention plus secondary prevention	Moderate	Adults
Insulin therapy for non-insulin-dependent diabetic individuals	Clinical: Primary care	Secondary prevention	Limited	Adults, elderly
Management of stable angina with medication	Clinical: Primary care	Rehabilitation plus secondary prevention	Limited	Adults, Elderly
Management of post-myocardial infarction or post-stroke patients	Clinical: Primary care, Public health, Behavior change	Secondary prevention	Moderate	Adults, Elderly
Low-cost medical management of unstable or myocardial infarction	Clinical: District hospital	Rehabilitation plus secondary prevention	Limited	Adults, Elderly
Cancer pain management	Clinical: Primary care	Palliation	Substantial	All ages
Onchocerciasis control with chemical pesticides	Public health: Environmental	Primary prevention	Moderate	All ages
Schizophrenia or manic-depressive illness treatment with medication	Clinical: Primary care	Rehabilitation	Moderate	Adults

$250–$1,000 per DALY

Referral of pharyngitis cases for antibiotic prophylaxis to prevent rheumatic fever and rheumatic heart disease	Public health: Screening and referral	Primary prevention	Limited	Childhood
Improved dengue case management via education of health care providers	Clinical: Behavior change	Primary prevention	Limited	All ages

> $1,000 per DALY

Medical and surgical management of chronic obstructive pulmonary disease	Clinical: Referral hospital	Rehabilitation plus palliation	Limited	Adults, Elderly
Surgery for rheumatic heart disease	Clinical: Referral hospital	Rehabilitation plus secondary prevention	Limited	Adults
Management of moderate hypertension with medication	Clinical: Primary care	Secondary prevention	Moderate	Adults, Elderly
Management of hypercholesterolemia with medication	Clinical: Primary care	Secondary prevention	Limited	Adults, Elderly
High-cost management of MI or unstable angina	Clinical: District hospital	Secondary prevention	Limited	Adults, Elderly
Management of coronary artery disease with surgery	Clinical: Referral hospital	Rehabilitation plus secondary prevention	Limited	Adults, Elderly
Medical and surgical management of cancers	Clinical: Referral hospital	Cure plus palliation	Limited	All ages
Dengue control with chemical pesticides with or without improved case management	Public health: Environmental	Primary prevention	Moderate	All ages
Dengue control via drainage and land management with or without improved case management	Public health: Environmental	Primary prevention	Limited	All ages

a. Age groups are defined as follows: Childhood = age 0 to 4; School age = age 5 to 14; Adults = age 15 to 59; Elderly = age 60 plus. Most interventions will be useful for a range of age groups; the principal age group to whom the intervention would be addressed is indicated.

b. DALY = disability-adjusted life-years.

Source: Tables 1A-3 and 1A-5.

Table 1A-7. Intervention Cost-Effectiveness by Objective

Cost per DALY	Number[a]	Primary prevention	Secondary prevention	Cure	Rehabilitation	Palliation
< $25	22	10	8	5	0	0
$25–$75	6	2	4	0	0	0
$75–$250	13	4	6	0	2	1
$250–$1,000	2	2	0	0	0	0
> $1000	9	2	5	1	3	2
Total	52	20	23	6	5	3

a. The total number of interventions does not equal the number of objectives, as some interventions have multiple objectives.
Source: Appendix table 1A-6.

Table 1A-8. Intervention Cost-Effectiveness by Public Health and Clinical Strategy

| | Public health | | | | | Clinical | | |
Cost per DALY	Environ-mental	Mass chemo-prophylaxis	Immunization	Screening and referral	Behavior change	Primary care	District hospital	Referral hospital
< $25	1	6	5	0	3	4	3	1
$25–$75	0	1	1	0	2	1	1	1
$75–$250	2	0	1	0	2	8	3	0
$250–$1,000	0	0	0	1	1	0	0	0
> $1,000	0	0	0	0	0	2	1	4
Total	3	7	7	1	8	15	8	6

Source: Appendix table 1A-6.

Appendix 1B: Countries and Territories as Grouped in this Collection

The table on the facing page lists the country and territorial groupings used for aggregating country into regional data throughout this collection. The *Industrialized transition econo-* mies grouping was previously labeled *Industrialized nonmarket economies.*

Analyses in the collection sometimes further aggregate countries into *industrialized economies* included in the first and second groups in this table and *developing economies* as shown in the third, fourth, fifth, and sixth groups.

Table 1B-1. Regional Groupings of Countries and Territories

Industrial market economies	Industrialized transition economies	Latin America and the Caribbean	Sub-Saharan Africa	Middle East and North Africa	Asia and the Pacific
Austrialia	Albania	Antigua and Barbuda	Angola	Afghanistan	Bangladesh
Austria	Bulgaria	Argentina	Benin	Algeria	Bhutan
Belgium	Czechoslovakia	Bahamas	Botswana	Bahrain	Brunei
Canada	Former German Dem. Rep.	Barbados	Burkina Faso	Egypt, Arab Rep. of	Cambodia
Channel Islands	Hungary	Belize	Burundi	Gaza Strip	China (excluding Taiwan)
Cyprus	Poland	Bolivia	Cameroon	Iran, Islamic Rep. of	Fiji
Finland	Romania	Brazil	Cape Verde	Iraq	French Polynesia
France	U.S.S.R.	Chile	Central African Republic	Israel	Guam
Germany, Fed. Rep. of	Yugoslavia	Colombia	Chad	Jordan	Hong Kong
Greece		Costa Rica	Comoros	Kuwait	India
Iceland		Cuba	Congo, People's Rep. of the	Lebanon	Indonesia
Ireland		Dominica	Côte d'Ivoire	Libya	Kiribati
Italy		Dominican Republic	Djibouti	Morocco	Korea, Dem. People's Rep. of
Japan		Ecuador	Equatorial Guinea	Oman	Korea, Republic of
Luxembourg		El Salvador	Ethiopia	Pakistan	Lao People's Dem. Rep.
Malta		Grenada	Gabon	Qatar	Macao
Netherlands		Guadeloupe	Gambia, The	Saudi Arabia	Malaysia
New Zealand		Guatemala	Ghana	Syrian Arab Republic	Maldives
Norway		Guyana	Guinea	Tunisia	Mongolia
Portugal		Haiti	Guinea-Bissau	Turkey	Myanmar
Spain		Honduras	Kenya	United Arab Emirates	Nepal
Sweden		Jamaica	Lesotho	West Bank	New Calednoia
Switzerland		Martinique	Liberia	Yemen, People's Dem. Rep. of	Pacific Islands
United Kingdom		Mexico	Madagascar	Yemen Arab Republic	Papua New Guinea
United States		Montserrat	Malawi	Other North Africa	Philippines
Other Europe		Netherlands Antilles	Mali		Singapore
Other North America		Nicaragua	Mauritania		Solomon Islands
		Panama	Mauritius		Sri Lanka
		Paraguay	Mozambique		Taiwan
		Peru	Namibia		Thailand
		Puerto Rico	Niger		Tonga
		St. Kitts and Nevis	Nigeria		Vanuatu
		St. Lucia	Réunion		Viet Nam
		St. Vincent and the Grenadines	Rwanda		Western Samoa
		Suriname	Saô Tomé and Principe		Other Micronesia
		Trinidad and Tobago	Senegal		Other Polynesia
		Uruguay	Seychelles		
		Venezuela	Sierra Leone		
		Virgin Islands (U.S.)	Somalia		
		Other Latin America	South Africa		
			Sudan		
			Swaziland		
			Tanzania		
			Togo		
			Uganda		
			Zaire		
			Zambia		
			Zimbabwe		
			Other West Africa		

Notes

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1. Issues associated with the health transition and its implications for policy are increasingly widely discussed; for example, see Bell 1992; Bicknell and Parks 1989; Bobadilla and others, chapter 3, this collection; Chen and others 1992; Chesnais 1990; Evans, Hall, and Warford 1981; Foege and Henderson 1986; Harlan, Harlan, and Oii 1984; Jamison and Mosley 1991; and Mosley and Cowley 1991. The work of Julio Frenk and his colleagues in Mexico—for example, Frenk and others 1989—has provided a particularly influential impetus for work in this area.

2. General economic conditions and behavioral patterns in society influence health outcomes (Bell and Reich 1988; Behrman 1990; Berman, Kendall, and Bhattacharyya 1989; Cochrane, Leslie, and O'Hara 1982; DaVanzo and Gertler 1990). This collection deals with these wider issues, for both adults and children, only insofar as they can be addressed by health-related intervention.

3. A comprehensive analysis of health problems of adults in the developing world that calls for more explicit policy and programmatic attention in addressing those problems has recently been completed for the World Bank (Feachem and others 1992).

4. A recent assessment of intervention options for mental disorders by the World Health Organization concludes—although treatment costs are not explicitly considered—that relatively simple interventions could be much more widely used to address widespread mental disorders (World Health Organization 1991).

5. The very different character of health interventions from other "goods" typically "chosen" by market forces—in particular consumer (and provider) ignorance about links between interventions and health improvement—generates a need for specialist assessment of intervention choice and for serious consideration of mechanisms that deal with market failure to decide on the level and composition of interventions to be provided. For a valuable review, see Barr 1992. A comprehensive approach to dealing with market failure through "managed competition" is provided by Enthoven 1988. Implications of this literature from the perspective of developing countries have been drawn in a major recent publication of the World Bank (World Bank 1993).

6. These elements need consideration, obviously, independently of whether the government, the private sector, or nongovernmental organizations are responsible for delivering the relevant service. Akin, Birdsall, and de Ferranti (1987) discuss these issues from the perspective of financing health systems; Birdsall (1989) further discusses the government role in the health sector; and Stiglitz (1989) provides a valuable general overview of the economic role of the state.

7. At about the same time, the World Health Organization was also beginning to address these issues; Dr. Hiroshi Nakajima, the current director-general, observed: "Even before we win our battle against the communicable diseases, which has engaged us since our earliest days, many developing countries must now, in addition, face the burden of ageing and chronic and degenerative diseases" (World Health Organization 1988, p. 102).

8. In many ways this review is very much in the spirit of Walsh and Warren's (1979, 1986) assessment of priorities for control of communicable childhood diseases in developing countries; the current effort involves more extensive use of economic analysis and covers a much broader range of conditions. In subsequent work for the United Nations Development Programme (UNDP), Walsh (1988) has extended her earlier work with Warren. Amler and Dull (1987) and the Department of Health and Human Services (1991) have reviewed a broad range of preventive intervention policies for the United States, and, more for clinical preventive services, the U.S. Preventive Services Task Force (1989) has reviewed the effectiveness of 169 interventions. The state of Oregon in the United States has ordered over 700 interventions, using cost-effectiveness and other criteria, for the purpose of rationing limited public resources to provide health care for the poor; a recent edited collection (Strosberg and others 1992) discusses many facets of the Oregon plan. Patel (1989) has reviewed estimates of cost and effectiveness of a range of health interventions for UNICEF, and Udvarhelyi and others (1992) provide a comprehensive review of medical cost-effectiveness and cost-benefit studies from the perspective of their methodological adequacy. All these approaches to the analytic evaluation of health practices fall within the general area of what is increasingly known as "health technology assessment"; Garber and Fuchs (1991) provide a valuable general overview of the field.

9. If one is simply assessing the relative attractiveness of alternative means for achieving a single, specific health objective—for example, reducing infant mortality—this measurement problem disappears, and one can judge intervention cost-effectiveness simply in terms of, say, cost per infant death averted.

10. There is at least anecdotal evidence to suggest that in immunization programs immunizations are often first provided where the cost per child contact is lowest; if, as is likely, these children have relatively low incidence rates (for example, of tuberculosis) or case-fatality rates (for example, of measles), then the Expanded Programme on Immunization may not be starting with the most cost-effective population subgroups.

11. In an early application of cost-effectiveness analysis within the health sector, Barnum and others (1980) go beyond comparing marginal cost-effectiveness to attempting an analysis of maximization of total outcome for different levels of expenditure on child survival; Forgy (1991) uses data from this collection on child survival to undertake a similar analysis.

12. It is important to recognize that some facilities address only a narrow range of conditions—for example, there are cancer and TB hospitals. Over and Piot (chapter 20) discuss the usefulness of clinics for sexually transmitted diseases, and Javitt (chapter 26) discusses use of mobile surgical camps (district-hospital level, in some sense) to deal with cataract.

13. Health care expenditures of approximately $460 billion in 1986 for the 242 million people of the United States well exceeded the GNP of China ($320 billion), with a population of 1.05 billion; it was close to triple the combined GNPs of all the World Bank member countries of Sub-Saharan Africa, which had a total population of about 425 million and a combined GNP of about $175 billion.

14. A separate line of evidence, albeit only suggestive, for inefficiency resulting from variation in marginal cost-effectiveness is the very high degree of observed variation in procedure frequence in somewhat similar environments (Sanders, Coulter, and McPherson 1989).

References

Akin, J., Nancy Birdsall, and D. de Ferranti. 1987. *Financing Health Services in Developing Countries.* Washington, D.C.: World Bank.

Amler, R. W., and H. B. Dull, eds. 1987. *Closing the Gap: The Burden of Unnecessary Illness.* New York: Oxford University Press.

Anderson, M. A. 1990. "Nature and Magnitude of the Problem of Suboptimal Breastfeeding Practices." Paper presented at the International Policymakers Conference on Breastfeeding, Florence, Italy, July 30–August 1.

Barnum, Howard. 1987. "Evaluating Healthy Days of Life Gained from Health Projects." *Social Science and Medicine* 24(10):833–41.

Barnum, Howard, R. Barlow, L. Fajardo, and A. Pradilla. 1980. *A Resource Allocation Model for Child Survival*. Cambridge, Mass.: Oeldeschlager, Gunn and Hain.

Barr, Nicholas. 1992. "Economic Theory and the Welfare State: A Survey and Interpretation." *Journal of Economic Literature* 30:741-803.

Basta, S. S., D. K. Soekirman, and N. S. Scrimshaw. 1979. "Iron Deficiency Anemia and the Productivity of Adult Males in Indonesia." *American Journal of Clinical Nutrition* 32:916-25.

Behrman, J. R. 1990. "A Survey on Socioeconomic Development, Structural Adjustment and Child Health and Mortality in Developing Countries." In K. Hill, ed., *Child Survival Programs: Issues for the 1990s*. Baltimore: Johns Hopkins University School of Hygiene and Public Health, Institute for International Programs.

Bell, D. E. 1992. "Some Implications of the Health Transition for Policy and Research." In L. Chen, A. Kleinman, J. C. Caldwell, J. E. Potter, and N. Ware, eds., *Health and Social Change*. Westport, Conn.: Auburn House.

Bell, D. E., and M. R. Reich, eds. 1988. *Health, Nutrition, and Economic Crisis*. Dover, Mass.: Auburn House for the Harvard School of Public Health.

Berman, P., C. Kendall, and K. Bhattacharyya. 1989. "The Household Production of Health: Putting People at the Center of Health Improvement." In *Towards More Efficacy in Child Survival Strategies: Understanding the Social and Private Constraints and Responsibilities*. Baltimore: Johns Hopkins University School of Hygiene and Public Health.

Bicknell, W. J., and C. L. Parks. 1989. "As Children Survive: Dilemmas of Aging in the Developing World." *Social Science and Medicine* 28(1):59-67.

Birdsall, Nancy. 1989. "Thoughts on Good Health and Good Government. *Daedalus* 118:23.

Briscoe, J. 1989. "Adult Health in Brazil: Adjusting to New Challenges." Report 7807-BR, World Bank, Washington, D.C.

Briscoe, J., and D. de Ferranti. 1988. *Water for Rural Communities*. Washington, D.C.

Bumgarner, J. R. 1992. *China: Long-term Issues and Options in the Health Transition*. A World Bank Country Study. Washington, D.C. World Bank.

Cairns, J., and K. Johnston. 1991. "Condition-Specific Outcome Measures as an Alternative to Across-Programme QALYs." Health Economics Unit, University of Aberdeen.

Chen, L., A. Kleinman, J. C. Caldwell, J. E. Potter, and N. Ware, eds. 1992. *Health and Social Change*. Westport, Conn.: Auburn House.

Chesnais, J-C. 1990. "Demographic Transition Patterns and Their Impact on the Age Structure." *Population and Development Review* 16(2):327-36.

Cochrane, S., J. Leslie, and D. O'Hara. 1982. "Parental Education and Child Health: Intracountry Evidence." *Health Policy and Education* 2:213-50.

Cropper, Maureen L., Sema K. Aydede, and Paul R. Portney. 1992. "Rates of Time Preference for Saving Lives." *American Economic Review* 82:469-72.

DaVanzo, J., and P. Gertler. 1990. "Household Production of Health: A Microeconomic Perspective on Health Transitions." Rand N-3014-RC. Rand Corporation, Santa Monica, Calif.

Drummond, M. F., G. L. Stoddart, and G. W. Torrance. 1987. *Methods for the Economic Evaluation of Health Care Programs*. Oxford: Oxford University Press.

Enthoven, Alain C. 1988. *Theory and Practice of Managed Competition in Health Care Finance*. Amsterdam: North Holland.

EuroQol Group. 1990. "EuroQol—A New Facility for the Measurement of Health-Related Quality of Life." *Health Policy* 16:199-208.

Evans, J. R., K. L. Hall, and J. Warford. 1981. "Health Care in the Developing World: Problems of Scarcity and Choice." *New England Journal of Medicine* 305:1117-27.

Fallowfield, Leslie. 1990. *The Quality of Life*. London: Souvenir Press.

Feachem, R. G. A., W. J. Graham, and I. M. Timaeus. 1989. "Identifying Health Problems and Health Research Priorities in Developing Countries." *Journal of Tropical Medicine and Hygiene* 92(3):133-91.

Feachem, R. G. A., T. Kjellstrom, C. J. L. Murray, Mead Over, and M. A. Phillips. 1992. *The Health of Adults in the Developing World*. New York: Oxford University Press.

Foege, W. H., and D. A. Henderson. 1986. "Management Priorities in Primary Health Care." In J. A. Walsh and K. S. Warren, eds., *Strategies for Primary Health Care*. Chicago: University of Chicago Press.

Forgy, Lawrence. 1991. "Cost-Effectiveness in Child Health: A Minimum Information Approach to Planning and Forecasting." Paper presented at the seminar on Child Survival Interventions: Effectiveness and Efficacy, at the Johns Hopkins University School of Hygiene and Public Health, Baltimore, June 20-22.

Frenk, J., J.-L. Bobadilla, Jaime Sepúlveda, and M. Lopez Cervantes. 1989. "Health Transition in Middle-Income Countries: New Challenges for Health Care." *Health Policy and Planning* 4:29-39.

Garber, Alan M. and Victor R. Fuchs. 1991. "The Expanding Role of Technology Assessment in Health Policy." *Stanford Law and Policy Review* 3:203-9.

Garber, Alan M., and Phelps, Charles E. 1992. "Economic Foundations of Cost-Effectiveness Analysis." Working Paper 4164. National Bureau of Economic Research, Cambridge, Mass.

Ghana Health Assessment Project Team. 1981. "Quantitative Method of Assessing the Health Impact of Different Diseases in Less Developed Countries." *International Journal of Epidemiology* 10(1):73-80.

Harlan, W. R., L. C. Harlan, and W. L. Oii. 1984. "Changing Disease Patterns in Developing Countries: The Case of Malaysia." In P. Leverton and L. Massi, eds., *Health Information Systems*. New York: Praeger Scientific.

Institute of Medicine. 1986. *New Vaccine Development: Establishing Priorities*. Vols. 1 and 2. Washington, D.C.: National Academy Press.

Jamison, D. T., J. R. Evans, T. King, I. Porter, N. Prescott, and A. Prost. 1984. *China: The Health Sector*. A World Bank Country Study. Washington, D.C.

Jamison, D. T., and W. H. Mosley. 1991. "Selecting Disease Control Priorities in Developing Countries: Health Policy Responses to Epidemiological Change." *American Journal of Public Health* 81:15-22.

Johannesson, Magnus. 1992. "On the Discounting of Gained Life-Years in Cost-Effectiveness Analysis." *International Journal of Technology Assessment in Health Care* 8:359-64.

Last, J. M., ed. 1988. *A Dictionary of Epidemiology*. 2d ed. New York: Oxford University Press for the International Epidemiological Association.

Leslie, Joanne. 1989. "Women's Time: A Factor in the Use of Child Survival Technologies?" *Health Policy and Planning* 4(1):1-16.

———. 1992. "Women's Time and the Use of Health Services." *IDS Bulletin* 23:4-7.

MMWR (*Morbidity and Mortality Weekly Report*). 1992. "Years of Potential Life Lost before Ages 65 and 85—United States, 1989-1990." MMWR 41(18):313-15.

Mosley, W. H., and P. Cowley. 1991. "The Challenge of World Health." *Population Bulletin* 46(4):1-39.

Mosley, W. H., and R. Jolly. 1987. "Health Policy and Program Options: Compensating for the Negative Effects of Economic Adjustment." In G. A. Cornia, R. Jolly, and F. Stewart, eds., *Adjustment with a Human Face*. Oxford: Clarendon Press.

Murray, C. J. 1990. "Rational Approaches to Priority Setting in International Health." *Journal of Tropical Medicine and Hygiene* 93(5):303-11.

Musgrove, Philip. 1991. "The Burden of Death at Different Ages: Assumptions, Parameters and Values." Occasional Paper 12. Latin America and the Caribbean Regional Office, Human Resources Division, Technical Department, World Bank, Washington, D.C.

Nord, Erik. 1991. "The Relevance of QALYs in Prioritizing between Different Patients." Paper presented at the 12th Nordic HESG meeting, Copenhagen, August.

Over, Mead. 1988. "Cost-Effective Integration of Immunization and Basic Health Services in Developing Countries: The Problem of Joint Costs." Working Paper 23. World Bank, Washington, D.C.

Patel, Mahesh S. 1989. "Eliminating Social Distance between North and South: Cost-Effective Goals for the 1990s." Staff Working Paper 5. UNICEF, New York.

Phelps, Charles E., and Alvin I. Mushlin. 1991. "On the (Near) Equivalence of Cost-Effectiveness and Cost-Benefit Analysis." *International Journal of Technology Assessment in Health Care* 7:12–21.

Pollitt, E. 1990. *Malnutrition and Infection in the Classroom*. Paris: UNESCO.

Preston, S. H. 1991. "Health Indexes and Health Sector Planning." Paper presented at the Workshop on the Policy and Planning Implications of the Epidemiological Transition in Developing Countries, at the National Research Council, Washington, D.C., November 20–22.

Rosser, R. M., and P. Kind. 1978. "A Scale of Valuations of States of Illness: Is There a Social Consensus?" *International Journal of Epidemiology* 7(4): 347–58.

Sanders, D., A. Coulter, and K. McPherson. 1989. "Variation in Hospital Admission Rates: A Review of the Literature." King's College Fund, Paper 79. London.

Squire, Lyn. 1989. "Project Evaluation in Theory and Practice." In B. Hollis Chenery and T. N. Srinivasan, eds., *Handbook of Development Economics*, Vol. 2. Amsterdam: North Holland.

Stiglitz, J. 1989. "On the Economic Role of the State." In A. Heertje, ed., *The Economic Role of the State*. Cambridge, Mass.: Basil Blackwell in association with Bank Insinger de Beauford NV.

Strosberg, Martin A., Joshua M. Weiner, and Robert Baker, with I. Alan Fein, (ed.) 1992. *Rationing America's Medical Care: The Oregon Plan and Beyond*. Washington, D.C.: The Brookings Institution.

Tan-Torres, Teresa. 1990. "Comparison of Different Methods of Eliciting Utilities for Outcome States in Leprosy." University of the Philippines, Department of Medicine, Clinical Epidemiology Unit.

Udvarhelyi, I. Steven, Graham A. Colvitz, Arti Rai, and Arnold M. Epstein. 1992. "Cost-Effectiveness and Cost-Benefit Analyses in the Medical Literature." *Annals of Internal Medicine* 116:238–44.

USDHHS (U.S. Department of Health and Human Services). 1991. *Healthy People 2000: National Health Promotion and Disease Prevention Objectives*. Washington, D.C.: U.S. Government Printing Office.

U.S. Preventive Services Task Force (R. S. Lawrence, Chairman). 1989. *Guide to Clinical Preventive Services*. Baltimore: Williams and Wilkins.

Walsh, J. A. 1988. *Establishing Health Priorities in the Developing World*. Boston: Adams Publishing Group for the United Nations Development Programme.

Walsh, J. A., and K. S. Warren. 1979. "Selective Primary Health Care—An Interim Strategy for Disease Control in Developing Countries." *New England Journal of Medicine* 301:967–74.

———, eds. 1986. *Strategies for Primary Health Care: Technologies Appropriate for the Control of Disease in the Developing World*. Chicago: University of Chicago Press.

Weinstein, N. D. 1989. "Optimistic Biases about Personal Risks." *Science* 246:1232–33.

WHO (World Health Organization). 1988. *From Alma-Ata to the Year 2000: Reflections at the Midpoint*. Geneva.

———. 1991. *Evaluation of Methods for the Treatment of Mental Disorders*. WHO Technical Report 812, Geneva.

World Bank. 1980. *Health Sector Policy Paper*. Washington, D.C.

———. 1992. *World Development Report 1992: Development and the Environment*. Washington, D.C.

———. 1993. *World Development Report 1993. Investing in Health*. Washington, D.C.

Zeckhauser, R., and D. Shepard. 1976. "Where Now for Saving Lives?" *Law and Contemporary Problems* 40:5–45.

Source: Dean T. Jamison, W. Henry Mosley, Anthony R. Measham, and Jose Luis Bobadilla (eds.). *Disease Control Priorities in Developing Countries.* New York: Oxford University Press for the World Bank. 1993.